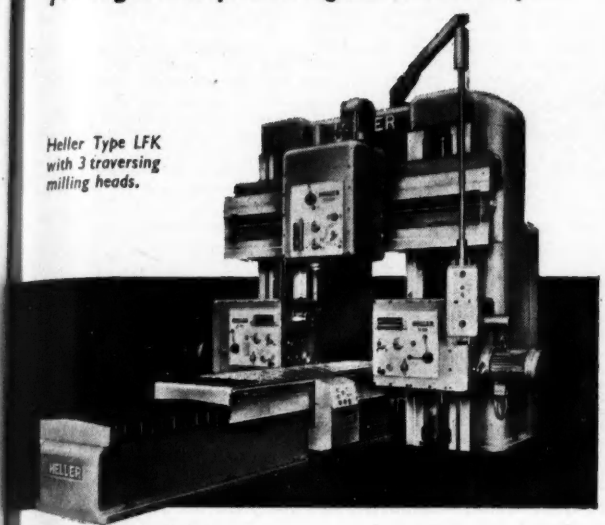
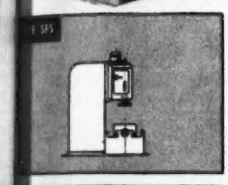
HELLER

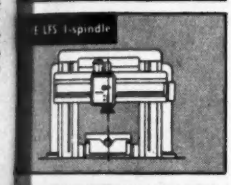
PLANO-TYPE MILLING MACHINES

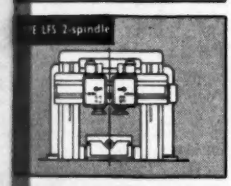
for higher output and greater economy

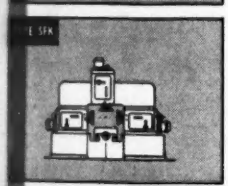


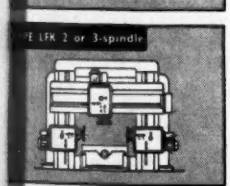
Heller Type LFK with 3 traversing milling heads.

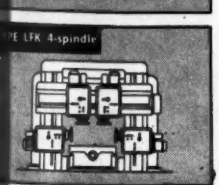












The simultaneous milling of several faces on one workpiece—often in different planes and at different angles—is the answer to the demand for increased output of many complex parts. It obviates reclamping and realigning and in many cases reduces the number of machines required for production.

Heller plano-type milling machines are designed on the unit-assembly system and can be literally 'built around the component'. The major units are the milling heads, tables, feed mechanism, uprights and frames. The selection of units depends entirely on the work required: for example, light milling heads and a large table can be used for bulky workpieces with only small faces to be milled, or alternatively heavy milling heads can be employed with a small table for heavy milling on small components. The power employed is therefore related to the workpiece and not to machine table size, and milling heads of different sizes can be fitted to the same machine. The economic advantages of this system of construction are therefore extended into actual operating, saving power and floor space.

Some of the most commonly used arrangements are shown opposite. There is a catalogue available which gives full details. Write for a copy now.

WICKMAN LIMITED

FACTORED MACHINE TOOL DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY
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THE ENGINEER

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NOTICE TO READERS
All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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LINEAGE RATE (Under 1 inch):—2s. 6d. per line of 6 words. Minimum 10s.

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WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

ROYAL TECHNICAL COLLEGE OF EAST AFRICA

(Principal : Major General C. BULLARD, C.B., C.B.E., B.Eng., M.I.Mech.E., M.I.E.E.)

HEAD OF THE DEPARTMENT OF ENGINEERING

Applications are invited for the post of HEAD of the DEPARTMENT of ENGINEERING.

The College, established under an autonomous Governing Council by the Royal Technical College of East Africa Act, 1954, is being built in Nairobi as the main instrument in British East Africa of higher technical and commercial education, to cater for students of all races. Teaching will be up to professional level in technical and commercial subjects, with strong supporting departments of science and arts. Mainly residential, the College is expected to contribute substantially to the social and cultural as well as the economic development of the region.

Candidates should have good Hons. Degree, Corporate Membership of one of the three main professional Institutions and senior experience in a Technical College or University. In the present early stage of development, organisation and equipment will be first requirements. It is hoped to appoint Lecturers and Assistant Lecturers early in 1955 and to accept first students later that year.

Salary scale (including temporary C.O.L.A.) £1850 by £50 to £2050 p.a., or slightly lower for transferred staff wishing to retain Col. Govt. pension rights. (Scale quoted is for staff who would contribute to proposed College pensions scheme or maintain existing rights under, e.g. F.S.S.U. or Ministry of Education, with College paying employer's contribution.) Appointment would be made for one tour of 24–36 months in first instance with view to permanency. Partly furnished house or flat will be provided, rent £150 p.a. Staff may be required to live in hotel in first instance and would receive allowance towards additional expenses. Free first-class passages to and from Kenya will be provided for person appointed and wife, and up to equivalent of one adult fare for dependent children under 21. Leave on full salary at rate of four days for each month's resident service.

Write for further information to Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 1, Gordon Square, London, W.C.1. Closing date for applications (six copies), 20th July, 1954. E9473

CARMARTHENSHIRE EDUCATION COMMITTEE

LLANELLY TECHNICAL COLLEGE

FULL-TIME ASSISTANT MASTER IN ELECTRICAL ENGINEERING

Applications are invited for the post of FULL-TIME ASSISTANT MASTER in ELECTRICAL ENGINEERING and allied subjects.

Candidates should possess a Degree or equivalent qualification, industrial experience, and preferably some teaching experience.

Salary in accordance with the Burnham Further Education Report, 1951, for Grade B Assistants, including allowances for teaching and approved industrial experience.

Duties to commence as soon as possible.

Further particulars and forms of application, which must be returned within two weeks of the appearance of this advertisement, may be obtained from the undersigned on receipt of a stamped, addressed envelope.

IORWERTH HOWELLS,
Director of Education.

Education Offices,
County Hall,
Carmarthen. E9545

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

LEICESTERSHIRE

Principal : H. L. HASLEGRAVE, Wh.Sc., M.A. (Cantab), Ph.D. (London), M.Sc. (Eng.), M.I.Mech.E., M.I.E.E., M.I.Prod.E.

INDUSTRIAL ENGINEERING

Applications are invited for the new post of HEAD OF THE INDUSTRIAL ENGINEERING DEPARTMENT.

Very wide scope and considerable prospects are offered to a well-qualified engineer who has had responsible industrial experience, and is able to teach, at the highest level, some of the industrial engineering subjects of work study, production planning, production processing and control, industrial administration, human relations.

The salary offered will be determined by the qualifications and experience of the successful applicant, and within the scale of £1490 to £1640. The post is pensionable.

Applications should be sent as soon as possible to the Registrar, from whom further particulars may be obtained. E9508

COUNTY BOROUGH OF EAST HAM

APPOINTMENTS

SENIOR ENGINEERING ASSISTANT, Grade VI, £695–£760.

TEMPORARY ESTIMATOR, Grade V, £620–£670.

London weighting is paid in addition. Salary in excess of the minima may be paid according to qualifications and experience.

Subsistence allowances may be granted over a reasonable period to persons appointed if unable to obtain suitable housing accommodation, necessitating the maintenance of two homes.

Further details and application forms returnable, by 23rd July, 1954, from the Town Clerk, Town Hall, East Ham, E.6. E9552

PUBLIC APPOINTMENTS

SUDAN GOVERNMENT

KHARTOUM TECHNICAL INSTITUTE

HEAD OF THE DEPARTMENT OF ENGINEERING

The Director of Education invites applications for the post of HEAD of the DEPARTMENT of ENGINEERING in the Khartoum Technical Institute.

Candidates who have held a similar appointment (not less than Grade II of the Burnham Technical Scales of salary) are preferred. Consideration will be given, however, to candidates who have either held or hold an appointment as Senior Lecturer, or a post of responsibility in the engineering industry.

Appointment will be on short-term contract with bonus determinable at any time by six months' notice from either side, provided that on or after 1st April, 1955, the period of notice shall be three months and not six. Salary scale ranges from £E1750 to £E1975 per annum (annual increments of £E75).

A cost-of-living allowance, which is reviewed quarterly, is also payable. Outfit allowance of £E50 is payable on appointment. Free passage on appointment, annual leave after the first tour. At present there is no income tax in the Sudan.

Further particulars and application form will be sent on receipt of a postcard only, addressed to the Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Head Engineering" and name and address in block letters. E9472

CITY OF SHEFFIELD

SEWAGE DISPOSAL DEPARTMENT

PRINCIPAL ASSISTANT ENGINEER

Applications are invited from persons who are Corporate Members of a Chartered Engineering Institution, and who have had extensive experience in the design and construction of engineering projects of a public works character, for the permanent appointment of PRINCIPAL ASSISTANT ENGINEER in the Sewage Disposal Department.

In the first place, the successful applicant will be required to assist the General Manager and Engineer (Mr. J. H. Edmondson, M.I.Mech.E., M.I.Chem.E.) in the preparation of a scheme for the reconstruction of the main works of the Department which will probably cost three-quarters of a million pounds.

The salary attached to the appointment will be within the scale of £1000 by £50 to £1150 per annum and the actual starting point in the scale will depend upon experience and qualifications.

The appointment is subject to a medical examination, superannuation, three months' notice on either side and the usual conditions of service. Housing accommodation is available at a rent, if required.

Applications, stating age, qualifications, present and past appointments with two recent testimonials, must reach me on or before the 24th July, 1954.

Canvassing, whether direct or indirect, is prohibited and will be a disqualification.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1. E9577

NATIONAL PHYSICAL LABORATORY

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

EXPERIMENTAL OFFICERS OR ASSISTANT EXPERIMENTAL OFFICERS

Department of Scientific and Industrial Research require EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS at National Physical Laboratory, Teddington, on design of research equipment and instruments. Candidates should be able to produce designs to instructions and to follow them through the workshops. Qualifications : E.O. at least 26 with H.N.C. Engineering or equivalent ; A.E.O., 18–22, with G.C.E. at Advanced Level in Scientific or Mathematical Subjects, over 22, H.N.C. in Engineering or equivalent. Prospects of permanent pensionable posts for E.O. under 31 and A.E.O. under 28. A 45½-hour week in the range E.O. (men) £741–£915, (women) £643–£782 ; A.E.O. (men) £298 (at age 18) to £664, (women) £298 (at age 18) to £561.—Application forms from M.L.N.S. Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting reference C.442/54A. Closing date 14th August, 1954. E9530

ASSISTANT ENGINEERS (CIVIL)

LONDON OFFICE

ASSISTANT ENGINEERS (CIVIL) required for their London office by the Crown Agents for Oversea Governments and Administrations. Basic salary scale £650 by £25 to £750 by £30 to £960 by £40 to £1000, plus extra duty allowance of approximately 8 per cent. The £650 minimum is linked to entry at age 25 and is subject to increase at the rate of one increment for each year above that age up to 34. Fully qualified officers at least 27 years old may be eligible for a special increase of £75 after two years' service. Engagement on unestablished terms with prospect of appointment to the established staff and of promotion. Candidates must be Corporate Members of either the Institution of Civil Engineers or the Institution of Structural Engineers ; or, if below the age of 26, must have passed the Associate Membership Examination of either of these Institutions or hold an exemption Degree. They must be good draughtsmen and should have had experience in the design and detailing of steel bridges and other steel structures, and should have served in the drawing-office of a structural firm, railway company or consulting engineers.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2A/30245/EH. E9497

PUBLIC APPOINTMENTS

PAKISTAN INDUSTRIAL DEVELOPMENT CORPORATION

APPOINTMENTS

The Secretary, Pakistan Industrial Development Corporation, Aimai House, Victoria Road, Karachi (Pakistan), invites applications in triplicate with three passport size photographs for (a) one WORKS MANAGER, (b) one CHIEF ENGINEER, (c) four WORKS ENGINEERS, and (d) one CHIEF ENGINEER (Sulphate Section of Ammonium Sulphate Plant), for a 50,000 tons ammonium sulphate fertilizer project at Daudkhel, District Mianwali, Punjab. Qualifications for (a), M.Sc. or Degree in Chemical or Electrical or Mechanical Engineering. Should have worked as production engineer in chemical industry (nitrogen or coal derivatives) and as chief engineer for at least five years. Age 35 to 45 years. Pay, between 2,500 Rs. and Rs. 3,000 p.m., inclusive of all allowances. Qualifications for (b), M.Sc. in Chemistry or Degree in Electrical or Mechanical or Chemical Engineering. Should have at least 10 years' experience as an engineer in chemical industry, of which five years should be as production or preferably chief engineer in a fertiliser factory. Age 35 to 45 years. Pay, between Rs. 2,000 and Rs. 2,500 p.m., inclusive of all allowances. Qualifications for (c), M.Sc. in Chemistry or Degree in Chemical Engineering. Should have at least five years' experience in chemical industry. Candidates with experience of mechanical engineering will be preferred. Age, between 30 to 40 years. Pay, between Rs. 1,000 and 1,500 p.m., inclusive of all allowances. Qualifications for (d), at least Degree in Chemical Engineering. Should have five years' experience in mineralogical chemical industry. Preference will be given to candidates with experience of corrosion problems. Age 30 to 45 years. Pay, between Rs. 1,500 and 2,000 p.m., inclusive of all allowances.

The applications should be submitted duly completed on prescribed proformas to the Secretary, Pakistan Industrial Corporation, Aimai House, Victoria Road, Karachi, with a copy simultaneously to Messrs. R. E. B. Willcox and Co., Prince Rupert House, 64, Queen Street, London, E.C.4, on or before the 31st July, 1954. Proformas available on request from Messrs. R. E. B. Willcox and Co. E4286

SOUTH WEST MIDDLESEX HOSPITAL MANAGEMENT COMMITTEE

ENGINEER

Applications are invited for the post of ENGINEER, who will, under the general direction of the Group Engineer, be responsible for the immediate supervision, maintenance and operation of the engineering services at King Edward Memorial Hospital, Ealing (145 beds), Perivale Maternity Hospital, Greenford (52 beds), Clayponds Hospital, South Ealing (114 beds), Queen Victoria Hospital, Hanwell (17 beds), and Ealing Chest Clinic. Whitley Council conditions of service and salary on scale £475 by £20 to £575, plus London weighting.

Applicants must have completed apprenticeship and have sound practical training in mechanical engineering, and must possess at least Ordinary National Certificate in Mechanical Engineering.

Residential accommodation will be provided for which rent will be payable approximately 20s. weekly (including rates).

Applications, giving details of age, experience and qualifications, must reach the Group Secretary, West Middlesex Hospital, Isleworth, Middlesex, by 17th July, 1954. E9587

BRITISH ELECTRICITY AUTHORITY

MIDLANDS DIVISION

SENIOR ASSISTANT ENGINEER (CIVIL)

SENIOR ASSISTANT ENGINEER (Civil) is required in the Chief Generation Engineer's (Construction) Department at Divisional Headquarters, N.J.B. service conditions, superannuable appointment, salary within Schedule C, Grade 1, commencing in range £970 to £1103, ultimately rising to £1198 per annum.

Applicants should be experienced in the design and construction of heavy foundations, structural steel and ferro-concrete frames, and building works associated with modern power stations, including office blocks, canteens, and similar structures. The work also involves the preparation of specifications, the examination of tenders, the supervision of contracts and approval of contractors' designs. Applicants should preferably be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications.

Apply, quoting Vacancy No. 703MD, on form AE6 available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 24th July, 1954. E9556

ADMIRALTY

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICER AND SCIENTIFIC OFFICER

SENIOR SCIENTIFIC OFFICER and SCIENTIFIC OFFICER required in Experimental Establishments in London, Portsmouth, Weymouth and Gloucestershire areas and Scotland. The majority of posts are for Engineers and Physicists (particularly with Electronics). Candidates must be British subjects with an appropriate First or Second Class Honours Degree or equivalent high professional attainments. Salaries : S.S.O. (M), £975–£1150 ; S.O. (M), £470–£855. London rates. Somewhat lower in Provinces. All appointments are unestablished (with F.S.S.U.) but with some opportunities to compete for established posts. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A246/52/A. E9226

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF BARNSLEY

WATERWORKS DEPARTMENT

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited from Chartered ENGINEERS for appointment as ASSISTANT ENGINEER in an established post in the works Department, at a salary in accordance Grades VI/VII of the National Scales for Authorities' Staffs.

The appointment will be subject to (a) the of Conditions of Service for A.P.T.C. Staff ; other general conditions of employment in within the Corporation from time to time ; one month's notice on either side.

The appointment will also be subject to Government Superannuation Acts, for which pose the successful candidate will be required a medical examination.

Forms for the guidance of applicants obtained from the Waterworks Engineer and ager, Waterworks Office, Town Hall, Yorkshire, by whom applications should be not later than the 31st July, 1954.

Canvassing will disqualify.

A. E. GILFILL
Town

Town Hall,
Barnsley,
24th June, 1954.

HER MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT, UG

ASSISTANT/EXECUTIVE ENGIN

Applications are invited for the above posts

Duties will include preliminary investi design and construction by direct labour of sewerage and storm-water drainage, &c.

Appointment on agreement. Gross emo ranging from £1120 to £1940 p.a.; £30 outf ance payable ; free passages, generous le medical attention. Quarters available at rental.

Candidates, who should be between 26-4 of age, must hold a University Degree or recognised as exempting from the Final Par II of the A.M.I.C.E. examination, plus min two years' approved professional experi A.M.I.Mun.E. Experience in excess of the together with service in the Forces, will be in determining salary.

Full details on application.

Apply in writing to the Director of Rec Colonial Office, Great Smith Street, London giving briefly age, qualifications and ex Mention the reference number BCD 112/9

NATIONAL PHYSICAL LABORATORY

TEDDINGTON, MIDDLESEX

ASSISTANT EXPERIMENTAL OF

National Physical Laboratory, Teddington sex, require ASSISTANT EXPERIM OFFICERS (unestablished) for work in mathematics, mechanical and electrical en and naval architecture. Age 18 or over wi to include at least two scientific or mat subjects at advanced level. Candidates ov normally be expected to have a Pass Degre or equivalent qualifications. Prospects of ment for candidates under 28. Inclusiv remuneration for a 45½-hour week in the ra £298 (at age 18) to £664 (women) £298 (at a £561.—Application forms from M.L.N.S., and Scientific Register (K), 26, King Street S.W.1, quoting A316/53A. Closing d August, 1954.

PRODUCTION ENGINEERI RESEARCH ASSOCIATIO

RESEARCH ENGINEERS

Production Engineering Research As vacancies for RESEARCH ENGINEERS. tions are invited from Engineers to research on machine tools, machining pressworking of metals and allied subjects. dates should have a First or Second-Class Degree. For men with initiative there opportunities for advancement. Superan under F.S.S.U. Full details, including ap ence, qualifications and salary required to P.E.R.A., Melton Mowbray, quoting R.19

LONDON COUNTY COUN

CIVIL ENGINEERS, CIVIL ENGIN ASSISTANTS AND DRAWING STAFF

CIVIL ENGINEERS, CIVIL ENGIN ASSISTANTS and DRAWING OFFICE for design of large civil engineering works i tion with main drainage and sewage pu Applications form from Chief Engineer London County Council, County Hall returnable within next 14 days. (Enclos (727).

THE ENGINEER

JULY 9, 1954

Liquid Fuel Burning Installations

RECENTLY the Council of the British Oil Burner Manufacturers' Association, submitted a memorandum on industrial liquid fuel burning installations to the air pollution industrial sub-committee of the Ministry of Fuel and Power. The memorandum deals with installations rated at not less than 500,000 B.Th.U. per hour and air pollution by smoke and unburnt products of combustion. Overloading of plant, inadequate ventilation, faulty chimney design and inefficient operation are given as the most common causes of smoke, and these are dealt with in the appropriate sections of the memorandum which are entitled design, installation, operation and maintenance, training of operatives and instrumentation. In the design section it is advocated that the burner manufacturer should be given full data concerning the application and it is pointed out that some boilers are more suitable for oil firing than others. New plant should include provision for expansion, and this should apply to the size and capacity of components; in addition it is suggested that, if possible, standby auxiliary units should be provided. The question of careful attention to ventilation is stressed and recommendations are made with regard to chimney design and the provision of ample draught. Fuel burners are divided into three main groups, and the memorandum emphasises that the selection of a burner should not be based upon first cost; it then goes on to suggest that old installations should be examined with a view to modernisation. Other points discussed in the design section are combustion chambers, preheating of oil and air controls. The memorandum recommends that the manufacturer should install all oil-burning plant and then proceeds to call attention to various items connected with the operation and maintenance of oil-burning plant. This is broadly divided into three main groups, having varying operating conditions, namely: hand controlled, high/low flame design, and fully automatic plant. On the question of the training of operatives it is recommended that advantage should be taken of instruction courses at the manufacturers' works. The memorandum concludes with a note upon instrumentation, the instruments being divided into three groups, and it is suggested that those in the third group, such as CO_2 indicators, draught gauges, and smoke density indicators, should be more extensively used.

Alkali Inspectors' Report for 1953

THE ninth annual report on alkali and associated process works, just published, shows that the number of works registered last year under the Alkali, &c., Works Regulation Act, 1906, was 950, involving the operation of 1775 separate processes. It notes that the recovery from the 1952 trade recession was steadily maintained during the year, and that the demand for sulphuric acid, nitric acid, dyestuffs, pharmaceuticals, chlorine, &c., was in excess of supply. Many further expansions and developments were planned to meet this demand. The report discusses ways of dealing with refuse from collieries in order to minimise the risk of spoilbank fires. It points out that the ideal way would be to dispose of all refuse underground by stowing it in old galleries, but in many collieries this method is impracticable. In a list of possible measures which could be used in connection with new spoilbanks it is pointed out that as far as possible all combustible matter should be removed and spoil should be crushed to 2in size to facilitate combustion. Experience has shown that conical tips are more liable to fire than any other kind and are more difficult to control when on fire, whereas embankment tips are the easiest to control. When starting a new spoilbank the removal of the top soil helps to prevent slipping and the inception of fire at the fault. Much of the report is devoted to the troubles experienced with atmospheric pollution in the neighbourhood of generating stations, industrial furnaces, gasworks, cement works, chemical works, &c.

Atomic Energy Authority

THE Minister of Works, Sir David Eccles, stated recently in Parliament that the following members had been appointed to the Atomic Energy Authority as from July 19th :—Sir Edwin Plowden (chairman), Sir John Cockcroft, Sir Christopher Hinton, Sir William Penney, Sir Donald Perrott (full-time members), Lord Cherwell, Sir Luke Fawcett, and Sir Ivan Stedeford (part-time members). It was intended to appoint one additional member shortly. The chairman's salary would be £8500 per annum, full-time members were to receive £5000, and part-time members £500, with the exception of Lord Cherwell, who had declined his salary. In addition, Sir John Cockcroft, Sir Christopher Hinton, and Sir William Penney would receive £1000 in their executive capacities. Sir David stated that the Authority was to commence its function under the 1954 Act on August 1st. Members of the House criticised the amount of the salaries as being contrary to the present tendency of keeping Government expenditure down, and it was also said that it was unsound practice and liable to lead to confusion for executives to be at the same time members of the controlling body, the Authority. Sir David, in his reply, said the manner of payment of the salaries was a matter of choice. On the question of the alleged confusion of functions, he said that the present arrangement achieved the object of co-ordination for which the Authority was set up in the first place, but that it was probably a temporary arrangement until such time as separate departmental managers could be found.

British Welding Research Association

THE British Welding Research Association's report for 1953–54 has just been published. Membership now includes 320 organisations, and it is stated that the Association's annual income for the first time has exceeded £100,000. New equipment which the Association has been able to obtain will be displayed at the Abington research centre on the forthcoming annual open day and the report says that, among future plans is the early transfer from London to Abington of the metallurgical research. In recording the many researches undertaken, the report states that low-alloy structural steels have been welded with low-hydrogen electrodes to give a 0·3 per cent proof stress of 35 tons per square inch (compared with 25 tons per square inch for the best alloy steels weldable with rutile electrodes). Dilution of the weld by the parent metal was found to be the cause of cracking in H.10 bridge deck units welded with Al-5 per cent Si. A cracking test was developed to compare different electrodes for this material. With high-strength, heat-treatable Al alloys new techniques have given stronger welds than those from commercial filler rods. The self-adjustment effect of high-density metal arcs was found to increase rapidly as the open-circuit voltage approaches the arc voltage; this means that the power source can be substantially different from that used with normal metal arc welding. A code of practice on projection welding of mild steel has been issued, and one on spot welding of low-carbon steel has been revised. A committee is to examine test methods for resistance welds, a field in which there is at present great lack of uniformity. Thin-gauge box section girders have been tested in bending and torsion. The method of welding is found to affect the fatigue limit, a result which, it is said, will influence chassis design. Docherty's experiments on " size effect " in brittle fracture of notched specimens have been repeated and the sudden change from brittle to ductile fracture with decrease in specimen sizes can now be explained. Velocity of propagation of brittle cracks has been calculated for the first time, and the result agrees well with requirement. Tests are in preparation to study the brittle fracture of wide plates under simulated practical conditions.

North Wales Gas Grid

IN connection with the work of planning the North Wales gas grid, which is now in its final stages, the chairman and the distribution engineer of the Wales Gas Board recently surveyed the proposed route of the main high-pressure pipeline during a three-hour flight in a helicopter. Mr. W. T. Hird, the distribution engineer, stated that by adopting this method of making a final overall examination of the route he was able to assess readily its suitability both on technical and æsthetic grounds. The survey took a matter of hours, where normally it would have taken some weeks to cover the ground. The North Wales gas grid, when completed, will consist of a high-pressure pipeline running from Llangollen through Wrexham to Connah's Quay and along the coast of North Wales as far as Caernarvon, with a branch over the Menai Straits to Anglesey. Gas will be supplied from the grid to twenty-five undertakings at present serving 70,000 consumers. It will comprise some 130 miles of high-pressure lines. The gas collected and distributed by the grid will come from three sources—a new gasworks recently completed at Maelor, about 3½ miles from Wrexham; coke oven gas from the Shotton works of John Summers and Co., Ltd.; and methane from the Point-of-Air colliery. The grid will be the first in this country to take as one of its sources of supply methane drained from a coal mine and reformed to be interchangeable with coal gas. It will also be the first system to use the modern pipelaying methods developed and used in the United States.

Water Supply Co-ordination

SPEAKING at Bournemouth on July 1st at the annual dinner of the British Waterworks Association, Mr. Ernest Marples, Parliamentary Secretary of the Ministry of Housing and Local Government, announced the proposed revival, in the autumn, of the Central Advisory Water Committee, under the chairmanship of the Minister, Mr. Harold Macmillan, who, said Mr. Marples, would like to see a speeding-up in the co-ordination of the water industry. The 1944 White Paper on a National Water Policy had mentioned the need for reducing the number of undertakings in the interests of operating efficiency. Since then the number had decreased by only 200, and was still nearly 1000. Smaller undertakings, in particular, should seriously consider during the coming year the possibility of combination, and it was hoped that the larger undertakings would co-operate when necessary. We understand that a sub-committee with strong scientific representation is to take over and enlarge the work of the former Advisory Committee on Inland Water Survey. River Boards are to be represented for the first time; applications by them for the approval of gauging and measuring schemes will be considered after October 1st.

Present-Day Locomotive Working in Great Britain*

By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E.

No. X : KING'S CROSS–EDINBURGH NON-STOP EXPRESSES—PART II

(*Continued from page 4, July 2nd*)

Since their first introduction by the L.N.E.R. in 1928, the London–Edinburgh non-stop trains run during the period of the summer service have provided the longest regularly-made non-stop run anywhere in the world. Successive accelerations have brought the overall speed up to the 1953 maximum of 58 m.p.h., and in this article the author concludes his analysis of the performance involved and recalls the development of the service from the original 47·6 m.p.h. timing of 1928.

THE concluding run described in Part I of this article showed a net time of 402 min for the 392·7 miles from King's Cross to Edinburgh. This represented a gain of 38 min on the schedule in force in 1951, when the run was made, and this margin for recovery was displayed despite the fact that the engine was not steaming freely at any time, and on occasions gave both her crews some periods of anxiety. The acceleration of the train during the summer of 1953 to an overall time of 405 min naturally cuts the margin for recovery to a much closer extent, even though the load is now limited to 400 tons tare. But the timekeeping has been excellent, in spite of numerous slacks temporarily imposed for permanent way work. The regular slowings are at Peterborough, Selby, York, Durham, Newcastle, Morpeth and Berwick, together with a severe slack over the site of a colliery subsidence at New Hailes, 5 miles east of Edinburgh. This latter restriction has been in force for so long that for the purpose of the summer service it can be considered as permanent. Allowance is made for it in the point-to-point times. The schedule requirements in the 6¼ h timing may be seen from the accompanying Tables

On the northbound journey the schedule makes fairly uniform demands from the locomotive except on three sections—from Peterborough to Grantham, where the timing is severe, and on the two sections marked in Table VIII, where there is a recovery margin. Between Retford and Doncaster there is a margin of 3½ min to 4 min while between Durham and King Edward Bridge Junction at least 2 min can be cut. On the southbound journey (Table IX) there is about 3 min in hand between Selby and Shaftholme Junction, and fully 7 min to 8 min between Hatfield and King's Cross. Before the 1939–45 war the regular express train timing inwards from Hatfield was 20 min. As on the northbound journey, some fast running is required between Grantham and Peterborough, and typical passing times necessary to maintain the 25½ min allowance have been inserted in the table for Stoke signalbox and Werrington Junction. The speed of 77·3 m.p.h. over the 20·6 miles between the two points is relatively easy to maintain with the "A4" engines. The heavy reductions of speed stipulated at stations such as Peterborough, York and Newcastle are always strictly observed, and the acceleration to express running speed afterwards entails vigorous working of the locomotive for the first mile or so.

So much for considerations of the schedules themselves ; reference may now be made to some actual runs with the accelerated trains. The stock used is relatively heavy in proportion to the seating accommodation provided, and the inclusion of a buffet car in addition to separate restaurant cars for first and third-class passengers means that against a tare load of 400 tons, for the eleven vehicles, the gross load behind the tender is 415 tons at the most. In the first week of the service, in July, 1953, the down train experienced three severe permanent-way checks, two lesser checks, and two checks from adverse signals in locations where speed rules high. But, above all, the train was stopped dead by signal at Little Benton Box, between Newcastle and Morpeth, and held there for 1 min. Despite this succession of delays, Edinburgh was reached precisely on time. The aggregate effect of these eight checks is estimated at 19 min, leaving the excellent net running time of 386 min, an average speed of 61 m.p.h. An admirable feature of the running was the recovery of time from the out-of-course slowings as soon as possible after they occurred. Thus Doncaster was passed slightly ahead of time, after five checks had occurred on the run down from King's Cross. A bad signal check at Thirsk put the train 4 min late through Darlington, but this loss had been completely recovered on passing Newcastle. The stop at Little Benton caused a further loss of 4½ min, and the last of the temporary permanent-way checks followed near Alnmouth Junction ; but by Monktonhall Junction the train was less than a minute late, and the arrival in Edinburgh, as previously mentioned, was precisely on time. The day was calm and fine, and the locomotive, No. 60009, "Union of South Africa," was in good fettle throughout. The Scottish driver was W. D. Stevenson, of Haymarket, who played such a large part in the working of non-stop runs between Edinburgh and London via the emergency route, via Kelso, in 1948. His English partner on this journey of 1953 was A. Smith, of King's Cross.

TABLE VIII—"*The Elizabethan*," *Northbound*

Miles		Schedule, min	Average speed, m.p.h.	Remarks
0·0	King's Cross	0	—	
17·7	Hatfield	26	40·8	
31·9	Hitchin	39	65·5	
58·9	Huntingdon	61	73·6	
76·4	Peterborough*	77½	63·7	
105·5	Grantham	106½	60·2	Severe
120·1	Newark	119	70·1	
138·6	Retford	136	65·3	
156·0	Doncaster	157	49·7†	
160·2	Shaftholme Junction	161½	56·0	E. to N.E. Region
174·4	Selby*	174½	65·5	
188·2	York*	189½	55·2	
189·8	Skelton Junction	192½	32·0	Recovery from slack
210·4	Thirsk	211	66·7	
218·2	Northallerton	218	66·8	
232·3	Darlington	230	70·5	
254·3	Durham*	253	57·4	
267·7	King Edward Bridge Junction	269	50·3†	
268·3	Newcastle*	271	18·0	Slow through Newcastle
284·9	Morpeth	292	47·4	
303·1	Alnmouth	310	60·6	
319·9	Belford	326	63·1	
335·2	Berwick*	340	65·6	
336·3	Marshall Meadows	342	33·0	N.E. to Scottish Region
351·4	Grantshouse	358½	54·9	
363·5	Dunbar	369½	66·0	
374·9	Drem	379½	68·5	
386·6	Monktonhall Junction	393½	50·2‡	
389·7	Portobello	399	33·8‡	
392·7	Edinburgh	405	36·0	

* Regular speed restrictions. † Schedule allows recovery time. ‡ Allowance for New Hailes pitfall slack.

TABLE IX.—"*The Elizabethan*," *Southbound*

Miles		Schedule, min	Average speed, m.p.h.	Remarks
0·0	Edinburgh	0	—	
3·0	Portobello	5½	32·7	
6·1	Monktonhall Junction	11	33·8†	
17·8	Drem	22	63·8	
29·2	Dunbar	32	68·5	
41·3	Grantshouse	46½	50·1	Heavy ascent
56·4	Marshall Meadows	60	67·1	Scottish to N.E.R.
57·5	Berwick	62	33·0	Slow through Berwick
72·8	Belford	77½	59·3	
89·6	Alnmouth	93½	62·3	
107·8	Morpeth	111½	60·7	
124·4	Newcastle	130½	52·4	
138·4	Durham	148	48·1	
160·4	Darlington	171½	56·2	
174·5	Northallerton	183½	70·5	
202·9	Skelton Junction	208½	68·2	
204·5	York	211½	32·0	Slow through York
218·3	Selby	226½	55·2	
232·5	Shaftholme Junction	244½	47·4‡	N.E. to E. Region
236·7	Doncaster	249	56·0	
254·1	Retford	266½	59·7	
272·6	Newark	283	67·2	
287·2	Grantham	296½	64·9	Rising gradients
292·6	Stoke Box	302*	58·9	Rising gradients
313·2	Werrington Junction	318*	77·3	
316·3	Peterborough	322	46·5	Slow through Peterborough
333·8	Huntingdon	339½	60·0	
360·8	Hitchin	363	68·9	
375·0	Hatfield	377	60·8	
392·7	King's Cross	405	37·9‡	

* Not in working timetable ; estimated times. † Allowance for New Hailes pitfall slack. ‡ Schedule allows recovery time.

* Previous articles in this series were : No. I, "The L.N.E.R. 2–6–2 'Green Arrow' Class," October 11, 1946 ; No. II, "The L.M.S.R. 'Coronation' Class 'Pacifics,'" December 13 and 20, 1946 ; No. III, "The G.W.R. Oil-Fired 4–6–0s," February 6 and 13, 1948 ; No. IV, "The Mixed Traffic 4–6–0s," November 4, 11, 18 and 25, 1949 ; No. V, "The Western Region 'Castle' Class," April 20 and 27, 1951 ; No. VI, "First Results from the 'Britannias,'" April 4, 1952 ; No. VII, "The Gresley 'Pacifics' on the East Coast Route," July 18 and 25, 1952 ; No. VIII, "The Thompson and Peppercorn 'Pacifics' of the Former L.N.E.R.," May 29 and June 5, 1953 ; No. IX "The 'King' Class 4–6–0s of the Former G.W.R.," July 10 and 17, 1953.

Analysing the actual locomotive work involved, the power output required by the schedule, and put forth on this trip, was no more than moderate between King's Cross and Peterborough. In pre-war days, the "A3" engines working through to Newcastle on the 1.20 p.m. Anglo-Scottish express from King's Cross used regularly to cover the 76·4 miles to passing Peterborough in little more than "level time" with loads of 500 to 530 tons; but they had the respite of station stops at Grantham, York and Darlington, and with a considerably shorter end-to-end run no anxiety about the fuel supply lasting out. On this particular run with the "Elizabethan" the engine was not unduly pressed on this first stage and after three checks, costing about 5 min between them, Peterborough was passed in 81½ min—4 min late. As with the "Coronation" train in pre-war years, however, it is nowadays becoming traditional to go really hard between Peterborough and Stoke summit, and this run with No. 60009 was no exception. Peterborough is scheduled to be passed at 20 m.p.h., and it takes a swift acceleration to cover the next 3·1 miles out to Werrington Junction in 4¼ min to 4½ min; furthermore, over the downhill stretch of 5·4 miles from Stoke summit to Grantham the fastest time one can expect is about 4¾ min to 5 min. Thus, if the full 29·1 miles from Peterborough to Grantham are to be run in the booked "Elizabethan" time of 29 min, pass to pass, the uphill section of 20·6 miles from Werrington to Stoke must be covered in 19½ min to 20 min. The line rises 315ft in this distance, an average inclination of 1 in 345. On the down "Elizabethan" engine No. 60009 was driven with such vigour as to gain a minute between Peterborough and Grantham, and it is interesting to compare this performance with those of some notable runs that have come to my notice (see Table X).

Of the above the performance on the high-speed "Coronation" train in 1937 is, of course, very fine; though it should be noted that this train made two intermediate stops between King's Cross and Edinburgh, and the engine crew was changed at Newcastle. The efforts of engines Nos. 60123 and 60520 were made in the course of shorter workings, and were considerably faster than the schedule requirements of either of the trains concerned. The performance of No. 60009 was the biggest output of power needed in the course of the "Elizabethan" run. The fast stretch between York and Darlington was interrupted by a signal check at Thirsk; but, even so, speed was not stabilising at much over 70 m.p.h. on this occasion. On the lengthy ascent north of Berwick the relative easiness of the engine working may be appreciated from the fall in speed from 62 to 48½ m.p.h. in 5 miles of 1 in 200 ascent, whereas on the Stoke bank earlier in the run speed fell from 68 to 61 m.p.h. on a similar length of 1 in 200 gradient. The maximum speed at any point during the journey was 82½ m.p.h.

TABLE X.—*Peterborough–Stoke Ascent*

Engine No.	Name	Class	Working	Distance, miles	Load, tons	Aver. speed, Werrington to Stoke	Calculated average d.h.p.
4490	"Empire of India"	A4	King's Cross-Edinburgh* ...	392·7	325	79·9	1780
60009	"Union of South Africa"...	A4	King's Cross-Edinburgh ...	392·7	415	65·1	1570
60123	"H. A. Ivatt"	A1	King's Cross-Leeds	185·8	450	68·2	1820
60520	"Owen Tudor"	A2/3	Peterborough–Newcastle ...	191·9	475	65·3	1770
60030	"Golden Fleece"	A4	King's Cross-Grantham ...	105·5	500	60·4	1640

* The "Coronation" express, in 1937.

In the southbound direction I have two runs made in rather different circumstances for discussion. The first of these two was recorded from a carriage in the train by Mr. Ronald I. Nelson on the second day of the service, and on the other run I was on the footplate for most of the journey. The results may be summarised as in Table XI:

TABLE XI.—*The Southbound "Elizabethan"*

Engine No.	60028	60017
Engine name	Walter K. Whigham"	"Silver Fox"
Load, tons gross	415	415
Weather	Calm, fine	Strong westerly wind
Number of checks	8	6
Time to passing Hatfield (375 miles), min	374½	382½
Time to arrival in King's Cross, min	399½	402½
Net time, min	386½	392
Maximum speed, m.p.h. ...	92	88

As previously mentioned, the booked passing time at Hatfield is in no more than 377 min from Edinburgh, leaving 28 min for the concluding 17·7 miles into King's Cross. Engine No. 60028 had done very well throughout and passed Hatfield ahead of time. There had been no exceptional running at any point; but the general level of performance had been well sustained. Two details only need to be specially mentioned. On the Cockburnspath bank, south of Dunbar, where the line rises at 1 in 96 for 4 miles speed fell only from 56 to 40½ m.p.h.; in the descent of the Stoke bank a rapid acceleration to 92 m.p.h. was recorded before the engine was eased down, since at this point the train was comfortably ahead of time.

On my footplate journey just over a week later, I saw one of the "A4" engines extended to a far greater degree. The cross-wind, which we felt immediately upon turning south some miles north of Berwick, was a serious handicap and must have increased our coal consumption very considerably. The engine, No. 60017, "Silver Fox," was one of the original quartet of silver streamlined engines built in 1935 specially for the "Silver Jubilee" train. It still holds the record for having reached the highest speed yet registered with a revenue-earning train in Great Britain—113½ m.p.h. with the up "Silver Jubilee" express on August 27, 1936. On the occasion of this recent trip the engine was in well-nigh perfect mechanical condition. The three-cylinder beat was very even and true; there were no signs of steam leakage at the fore end, and riding was very quiet, smooth and steady. But with the very best of engines some loss of steam pressure is liable to occur on a long non-stop run such as this, due to clinker tending to form in the bars. These engines are not fitted with rocking grates. We were fortunate, however, in having, one after the other, two very keen and attentive young firemen, and in the later stages of the journey when the wind was at its worst the boiler pressure was consistently above 215 lb per square inch and between 230 lb and 240 lb on the critical adverse section between Sandy and Knebworth. The mechanical condition of the engine, and the steadiness of the steaming needs emphasis because our progress in relation to the working adopted was well below the best "A4" standards. From a fairly extensive experience of footplate running with the Gresley "Pacific" engines I estimate that the wind on the exposed stretches of line was roughly equivalent to another 100 tons of load on the train, so that on lengths like those from Darlington to York, and from Peterborough to Hitchin our equivalent load was some 500 to 510 tons. I am only too well aware that the reverser scale does not always tell the correct story, particularly on the Gresley three-cylinder engines; but No. 60017 was extremely well tuned up and the cut-offs quoted hereafter may be taken as reasonably accurate. With a knowledge of what has been done recently with heavy-load engine tests I found myself wishing that we could have had a dynamometer car interposed between the tender and the train on this trip, for the sustained output of power was high.

In the early stages of the run south the Scottish driver adhered closely to the schedule time. The ascent of Cockburnspath bank was not so fast as that of engine No. 60028 on the journey previously referred to as speed fell to 34 m.p.h. But we passed from the Scottish to the North-Eastern Region dead on time, at Marshall Meadows signalbox—56·4 miles in exactly 1 h. It was on the open stretches south of Berwick that we first began to feel the effects of the wind, and at Chathill, where No. 60028 was running at 75 m.p.h. on level road, No. 60017 did not exceed 68 m.p.h., despite the use of a

Fig. 3—"The Elizabethan" at 70 m.p.h.—Engine "Walter K. Whigham"

wide open regulator, steam chest pressure 235 lb per square inch, and cut-off 15 per cent. In calm weather one could reasonably have expected a speed of nearly 80 m.p.h. from so excellent an "A4" with no more than 415 tons behind the tender. Two minutes were lost by a permanent way check near Alnmouth, and these had not been recovered by the time we passed Newcastle. Along the undulating stretch between Alnmouth and Morpeth, the difference between Nos. 60028 and 60017 was most marked; the average speeds over the 13·4 miles between Warkworth and Pegswood were 68·5 and 61 m.p.h. respectively. By some fast running between Durham and Darlington the Scottish driver had practically won back to schedule time at this latter point; but the strength of the wind was again amply demonstrated, when down the 1 in 650 gradient between Cowton and Danby Wiske speed did not rise above 72 m.p.h. Steam chest pressure was then 205 lb per square inch and cut-off 15 per cent.

Fig. 4—"The Elizabethan" inaugural journey—awaiting departure 9.35 a.m. from King's Cross

The London driver took over at Thirsk, just as we were recovering from a stiff relaying slack to 15 m.p.h., and in regaining speed he kept the cut-off at 20 per cent; this, with steam chest pressure varying between 230 lb and 235 lb per square inch, gave us a sustained 77½ m.p.h. on the long stretch of level track south of Alne. But 20 per cent was heavy working at this speed, and it was certainly reflected in the firing rate. We were 1½ min late through York and the same through Selby; but the easier point-to-point booking onwards to Doncaster provided the necessary recovery margin, and we passed the latter station 2½ min early—236·7 miles in 246½ min. The next 138·3 miles on to Hatfield are scheduled in 128 min—an average of 64·8 m.p.h. The driver had 2½ min in hand to offset the effects of a permanent way slack to come immediately south of Doncaster, but following this came a bad signal delay approaching Retford. At one moment it seemed that we should be stopped, though the signals were cleared just in time. The effect of this check, and the need to recover speed up the 1 in 178–200 gradient to Askham tunnel, was to put us 4½ min behind time at Newark, with the fastest piece of sustained running ahead of us—102·3 miles on to Hatfield in 94 min, nearly 66 m.p.h., including the slack to 20 m.p.h. through Peterborough station. At this stage in the journey the driver was having to watch his coal supply. The engine was steaming freely, and would have taken any amount of "hammering"; but if the fuel supply ran short any such vigour would be worse than useless. The only course was to hang on, keeping the point-to-point times, and hope for a clear road in from Hatfield, when we should benefit from the recovery margin available in those last 17¾ miles.

Actually, we ran from Newark to Hatfield in 94¾ min; of this total, however, 6¾ min were spent over the 4½ miles from Werrington Junction, through Peterborough, to Fletton Junction. The slack was more severe than usual, as we were diverted via the goods lines west of the station. There was much really hard running in that 95 min of the journey. On the rise from Newark to Stoke summit cut-offs of 22 to 25 per cent were used, and although there was some slight easing of the regulator on the descent towards Peterborough the steam chest pressure was rarely below 180 lb per square inch, with 15 per cent cut-off. Here, over the 17·6 miles from Corby Glen to Werrington Junction speed averaged 82·4 m.p.h., with a maximum of 88 m.p.h. We were now meeting squalls of rain in addition to the wind, and on the wet rails the engine was inclined to slip, even at quite high speeds. When this occurred several times on the Abbots Ripton incline and lowered our speed somewhat, I feared that we might lose ground to such an extent as not to keep time. At Huntingdon we had, indeed, dropped back to our maximum lateness of 6½ min. But the London fireman had now built up for a fine concluding effort, and with boiler pressure up to 240 lb per square inch the driver made an increase in cut-off from 15 to 17 per cent at Biggleswade. The speed was then 70 m.p.h., on virtually level road, and the rise of 12 miles to Stevenage lay immediately ahead. On a more sheltered stretch of line we now saw what this excellent engine could do with the "Elizabethan" load in calmer weather conditions.

The average gradient in the 12½ miles from Biggleswade to Stevenage is 1 in 333; the rise is easier at first, but steepening finally to 1 in 200 for 5 miles continuously. Without any advance beyond 17 per cent this stretch was covered at an average speed of 66 m.p.h., and while earlier in the run it had needed 25 per cent cut-off to climb from Grantham, and speed had fallen from 62 to 56 m.p.h. in 4 miles, in the more sheltered conditions south of Hitchin speed fell only from 64 to 58½ m.p.h. in 3½ miles of the same 1 in 200 inclination—using no more than 17 per cent. In passing, it is interesting to recall that the "Coronation" express of 1937 was required to average 78 m.p.h. between Biggleswade and Stevenage for timekeeping, with its tare load of 312 tons, against the 400 tons of the "Elizabethan." Reverting to the latter train, on my footplate journey we had won back to a lateness of no more than 5 min at Hatfield, and with a clear run into King's Cross the arrival was 2½ min early. The engine crews were Driver Storey and Fireman McGechie, of Haymarket, and Driver Edwards and Fireman Waterson, of King's Cross, while I was accompanied on the footplate by Inspector Cunningham, of the Scottish Region. I am much indebted to the Railway Executive for permission to make this interesting journey.

Comparison with the effort required on the "Coronation" is interesting. The pre-war train had some very fast timings south of Doncaster, but speed was then restricted north of York. The analysis shown in Table XII relates to the work between King Edward Bridge Junction and Hatfield:

TABLE XII.—*The "Coronation" and "Elizabethan" Compared*

	"Coronation"	"Elizabethan"
Booked average speed over 250 miles, K.E. Bridge to Hatfield, m.p.h.	68·5	61·4
Load, tons gross, behind the tender	325	415
Train resistance, pounds per ton (Johansen)	13·5	11·8
Average d.h.p.	802	802
Coal fired (assuming 3 lb per d.h.p. hour), tons	3·93	4·37

Thus, other factors being the same, the actual amount of coal used on the "Elizabethan" would tend to be higher than on the "Coronation," and since the former run is made non-stop the duty can, on this basis, be considered more exacting than that most spectacular of British pre-war trains. That the punctuality record has been so good is greatly to the credit of all concerned on the East Coast route.

Since this article was originally written the London-Edinburgh time has been further cut to 6½ h, with the reintroduction of the non-stop run for the duration of the 1954 summer service. The load remains the same as that of last year, approximately 400 tons tare, and the Gresley "A4 Pacific" engines are again being entrusted with the task. Earlier in this article reference was made to a run with the "Elizabethan" of 1953, on which time was kept despite a heavy cross-wind that blew throughout the distance from Berwick to the outskirts of London. A still finer performance was noted on the accelerated train of this summer, on which the fast booking of 362 min for the 375 miles from Edinburgh to passing Hatfield was kept with 2 min in hand, despite a series of delays *en route* that cost 10½ min to 11 min in running. Delays due to the widening works at Potters Bar accounted for a further 5½ min lost, though here the schedule had been made deliberately easy. So the train arrived in King's Cross 5 min early, with a net running time of only 369 min for the 392·7 miles from Edinburgh.

Some of the finest sustained high-speed running was between Darlington and York, where a stretch of 41·1 miles was covered in 31 min 13 sec, at an average of 79 m.p.h., while the maximum speed of the journey,

reached in descending the Stoke bank between Grantham and Peterborough, was 96 m.p.h. The weather was calm and fine throughout and the engine performance uniformly good ; but against these favourable conditions the net time quoted allows for a relatively slow finish from Hatfield into King's Cross, 20 min, and also for the severe reduction in speed required over the colliery subsidence district at New Hailes, on the eastern outskirts of Edinburgh. With undelayed running at the start and with a fast finish a further 4 min could be cut from this net time, leaving only 365 min—5 min over the even 6-hour which used to be run with the 312-ton " Coronation " express of 1937–39. Whether the process of time cutting, which has proceeded steadily since the end of the second world war, will be carried still further next year remains to be seen ; but the " A4 Pacific " concerned in this 1954 journey had some 21 min in hand on the present schedule, giving the net start-to-stop average speed of 63·8 m.p.h.

Gravity Dam Deflections

By SERGE LELIAVSKY, Ph.D., M.I.C.E., M.Am.S.C.E.

The author evolves a formula for gravity dam deflections including two factors only. It appears, nevertheless, to furnish reasonably consistent results. It must clearly be interpreted as an approximation to the true deflection, similar, in this respect, to Chezy's formula for canals. The accuracy of the formula is checked by reference to the observed deflections of certain dams.

DEFLECTIONS of gravity dams nowadays play an important part in both theory and practice of modern dam engineering, and an abundant volume of observational material relating thereto has therefore been collected. This material remains, however, unsystematised and represents, consequently, a dead ballast, a mass of isolated facts, without liaison with one another, owing to the lack of a consistent formula, applicable to any case. One of the difficulties in the way of devising such a formula is provided by the variety of factors which should (or could ?) be theoretically included. But for such a formula to be of practical value the number of these factors must of necessity be reduced to a minimum, comprising only those of them which are common to all dams, so as to bring out the anomalies, if any, caused by local influences, in certain specific cases, in which such secondary effects are indeed predominant.

In addition to the various factors traceable to the purely mechanical action of the water pressure, the deflections observed on existing dams are believed[1] to be due to various other physical causes also, e.g. the temperature, the swelling of the stone consequent on water absorption, &c. These additional factors are supposed to be responsible for the fact that the deflections are frequently observed to be greater than they should be, according to the usual, generally accepted, values of Young's Modulus. The problem is made almost insoluble by reason of the fact that the yearly cycles of these influences coincide in time with the operational cycles of water level regulation in the reservoir, which makes it impossible to assess correctly the respective influence of every individual factor, taken separately.

On an earlier occasion[2] the author took advantage of the fact that a section of the Aswan dam, though designed to the usual, quasi-triangular, profile of the current type of masonry dams, performs, nevertheless, the functions of a lock wall and, as such, is therefore capable of being subjected to several cycles of water pressure variations in one single day. Since the effect of the differences in the magnitudes of the secondary influences (i.e. temperature, swelling, &c.) during these short-time intervals is confined to a very shallow crust on the outer periphery of the dam only, their action is evidently negligible.

It follows, therefore, that since all other causes of deformation are eliminated, the movements of this particular part of the dam, which follow one another in rapid succession, can only be due to the mechanical external action of the water pressure. This theoretical conclusion was confirmed by the fact that the masonry was found to respond in almost clockwork fashion to the changes of the water level in the lock chamber ; in fact, when the observed movements were opposed to the filling operations, a statistical examination of the recorded figures yielded a correlation coefficient as high as 0·95.

But, notwithstanding the fact that all secondary causes were inoperative, the deformations (which, by the way, were of the order of 2½mm per cycle of water levels) proved to be still inconsistent with the traditional assumptions concerning the value of Young's Modulus. Should the usual standards, commonly appearing in reinforced concrete specifications, be taken as a basis for comparison, we ought to use for steel the value E=2,100,000 kg per square centimetre, and assume that n varies from 8 at very low stresses to 20 as a maximum, with 15 as the commonly accepted average. These frequently used figures yield, then, for concrete or masonry :—

E minimum	110,000 kg/cm²
E average	140,000 kg/cm²
E maximum	260,000 kg/cm²

But the results derived from the measurements made at the Aswan dam gave a value of E of 46,000 kg per square centimetre only. Such a low value was not altogether unexpected, for throughout the sixty-year period, during which deformations of finished masonry and concrete works have been recorded *in situ*, engineers have frequently been embarrassed to explain why there was more movement than apparently there should have been.

To illustrate the point at issue it may be of interest to choose for quotation the earliest and latest evidence bearing on the subject. So far as the author knows, the first measurements of the class herein referred to were undertaken, in the 1890's, by the Austrian Union of Architects and Engineers, in order to verify the validity of the elastic calculation method, in so far as full-sized arches were concerned.

The tests in question confirmed the theory but the published conclusions laid stress on the fact that the deformations were materially greater than had been initially anticipated, from the Young's Moduli determined by means of test specimens (the size of which was dictated by available laboratory facilities). *Faute de mieux*, this quantitative inconsistency was attributed then to qualitative differences between the microstructures of the materials in laboratory prepared test pieces and in full-sized arches respectively.

From this time onwards, measurements of deformations of large structures became gradually more and more frequent, and the bulk of the evidence thus obtained tended to confirm the extremely low value of the Young's Modulus observed on all finished work. The latest example among such evidence is provided by the figures quoted in a discussion on three Italian dams, which took place in the Institution of Civil Engineers, London, on March 18, 1952.[3] The figures quoted were 20,000kg to 30,000kg per square centimetre for E. The concrete seems to have been of particularly high strength, about 400kg per square centimetre in compression. Thus, from the information hitherto available the low Young's Modulus of finished work must be faced as a fact.

Existing Solutions

Several attempts at solving the problem of gravity dam deflections have been published by various authors. For example, there is a formula suggested, in 1931, by Professor Campus, of the Liège University.[4] It is not the author's intention either to discuss or criticise the mathematical methods upon which such equations are based ; they are far too complicated and intricate for the object of the present study.

Were we dealing with a more or less homogeneous material, for instance, steel, an equation taking into account all the physical and mechanical factors which might affect the result might prove valuable (though practice shows that even in such cases the effect of local factors may sometimes overshadow the intricacies of the theoretical analysis). But, taking into consideration the inherent lack of homogeneity, which is rather characteristic of concrete and masonry dams, it is hardly reasonable to expect to find close mathematical similarity of the constants affecting the deformations of these structures.

Under such conditions it may be more valuable to decide intuitively which among the various factors affecting the case can be or may be disregarded, rather than to try to imagine new influences, capable of accounting for discrepancies.

Width-to-Height Ratio

Since arithmetical and graphical methods for carrying out the integrations, forming a necessary part of the calculation of deflections, are cumbersome for the object of this study, analytical solutions have to be resorted to. Those solutions cannot be reached without, first, expressing the width of the dam as a function of its height, or, more precisely, of its depth below storage level.

With this aim in view, a number of modern dam profiles have been examined and the advantages of various possible empirical formulas compared, the objective being to simplify, as far as possible, the solution. Should a deeper insight be aimed at, the term " width," in the light of the theory of the strength of materials, must be interpreted as a dimension perpendicular to the bisector of the profile, rather than assumed identical with the structural horizontal width, as has

[1] Coyne, " Influence de Température Interne et Déformation des Barrages Poids," Rep. 9, First Congr. on Large Dams, Stockholm, 1933, page 72.

[2] Hamed Bey Suleiman and Serge Leliavsky Bey, " Observations of the Movements of the Lock Wall of Aswan Dam," *Proceedings*, Second Congr. on Large Dams, Stockholm, 1948.

[3] *Proc. I.C.E.*, Part I, September, 1952, page 543.

[4] The formula is reproduced *in extenso* by Monsieur André Nizery in Report 34 to the Third Congress on Large Barrages, Stockholm, 1948, page 32.

usually been done (since Sazilly's time) in calculating the stresses. The bisector concept was, indeed, employed by Résal[5] in establishing a theory of dam resistance, which was rather popular with French designers of the 1920s. But quantitative comparisons carried out by the writer show that though the bisector may bring a more rigorous solution, the complications resulting from its use, particularly in the lower part of the profile, are not compensated by a material improvement in the numerical result. The common inconsistency, which assumes the mediane as the elastic axis of the profile (i.e. the locus of the neutral points in pure bending), and, at the same time, uses horizontal sections (as those subject to linear stress distribution) is, therefore, accepted in what follows, as a reasonably close approximation. Since in accepting this inconsistency we already depart from the rigorously precise estimate of the width, it seems senseless to complicate the solution by any attempt at a hair-splitting academical accuracy elsewhere, and the simple formula $b=h \tan \alpha$, where α is the angle between the front and rear faces of the dam, is therefore adopted—in preference to the theoretically more precise equation $b=h(\tan \beta+\tan \delta)$, in which β and δ are the upstream and downstream batters respectively. The error involved in this approximation, i.e. $\tan \beta \times \tan \delta/(1-\tan \beta \tan \delta)$ is very small, since $\tan \beta$ seldom exceeds 5 per cent, whereas $\tan \delta$ averages about 70 per cent. Moreover, the upstream batter starts frequently at some depth, below the storage level, and the effective value of $\tan \beta$ must, then, be estimated by drawing an average line, and this results in still smaller percentages.

If a closer approximation is deemed necessary or advisable, the required correction can easily be introduced, in the form of an overall coefficient, in the final equations.

External Water Pressure

Though, according to modern views on the subject, the horizontal component of the external water pressure is applied (paradoxical though this may appear) internally, the corresponding bending moment may nevertheless be calculated as though the pressure acts on the water face of the dam[6]; which means that this moment is capable of being calculated by the simple equation $M_1=1/6 \cdot \gamma h^3$. Since, on the other hand, $b=h \tan \alpha$, and the second moment is $I=b^3 \cdot 1{\cdot}00/12=(h \tan \alpha)^3/12$, the horizontal component of the movement of the top of the dam, consequent upon the bending effect of the hydrostatic water pressure, is

$$\Delta_1=\int_0^H \frac{2\gamma h}{E \tan^3 \alpha} dh=\frac{H^2\gamma}{E \tan^3 \alpha}.$$

Owing to its somewhat involved interpretation (in the light of Fillunger-Terzaghi intersticial pressure theory), the vertical component of the hydrostatic pressure is, for the time being, disregarded. Its effect is, anyway, rather small as compared with other factors. On the other hand, tentative calculations show that the shearing stresses produce, in this case, deformations of the same (or almost the same) order of magnitude, as the bending stresses. The effect of the shearing stresses must, therefore, be taken into account as follows: the horizontal shear at any level is taken to be equal to $\gamma h^2 \times 1{\cdot}00/2$ and the corresponding area is $b \times 1{\cdot}00=h \tan \alpha$. Hence, the movement of the top of the dam due to these stresses is determined by the formula :—

$$\Delta_2=\int_0^H \frac{\gamma h}{2G \tan \alpha} dh=\frac{H^2\gamma}{4G \tan \alpha} \sim \frac{7H^2\gamma}{12E \tan \alpha}.$$

Numerical examples show that Δ_2 calculated from this formula may be as much as 50 per cent of the deformation due to bending stresses, whereas in beams the ratio seldom exceeds 5 to 10 per cent.

Uplift

In the Aswan observations referred to earlier, the uplift remained neutral. For the period of the cycle of water level variation was too short for the interstitial pressure to be affected, and to influence, in turn, the movements. In other dams, however, for which the cycle of operation is one year, the uplift, inside of the dam, has time enough to adjust itself to the weekly or monthly average level of the water surface, in the reservoir. It must, therefore, be taken into account, in the calculation of the yearly movements of the masonry or concrete structure.

The horizontal component of the interstitial pressure has already been accounted for in calculating Δ_1. It remains, consequently, to calculate the effect of the vertical component only, which, following the usual, linear principle, is a bending moment $ub^2/12$, where u is the interstitial pressure at the upstream face, viz. the hydrostatic pressure γh multiplied by the effective area factor, f_e, which the author found experimentally to be equal to 0·85[7]. Since the second moment in the denominator is the same as in the formula for Δ_1, it follows that the deflection due to uplift is :—

$$\Delta_3=\int_0^H \frac{f_e\gamma h dh}{E \tan \alpha}=\frac{f_e\gamma H^2}{2E \tan \alpha}=\frac{0{\cdot}425\,\gamma H^2}{E \tan \alpha}.$$

Total Deflection

The total deflection is therefore the sum $\Delta_1+\Delta_2+\Delta_3$. Hence,

$$\Delta=\frac{H^2\gamma}{E \tan^3 \alpha}+\frac{7}{12}\frac{H^2\gamma}{E \tan \alpha}+\frac{0{\cdot}425\,\gamma H^2}{E \tan \alpha}$$

$$=\frac{\gamma H^2}{E} \times \frac{1+1{\cdot}01 \tan^2 \alpha}{\tan^3 \alpha}$$

or very nearly

$$\Delta=\frac{\gamma H^2}{E} \times \frac{1+\tan^2 \alpha}{\tan^3 \alpha}.$$

This is believed to be the simplest equation ever recommended for practical use.

Should the deflection, Δ, be known from field observations, this formula is suitable for the calculation of the modulus of elasticity (Young's Modulus). For example,

$$E=\frac{\gamma H^2}{\Delta} \times \frac{1+\tan^2 \alpha}{\tan^3 \alpha}=\frac{\gamma H^2 K}{\Delta}$$

where

$$K=\frac{1+\tan^2 \alpha}{\tan^3 \alpha}.$$

Should particular structural means be taken to remove the uplift pressure, then, in the period in which these means are truly efficacious, the equations would change into :—

$$\Delta=\frac{\gamma H^2}{E} \times \frac{1+0{\cdot}58 \tan^2 \alpha}{\tan^3 \alpha}=\frac{\gamma H^2 K_1}{E}$$

and

$$E=\frac{\gamma H^2}{\Delta} K_1,$$

where

$$K_1=\frac{1+0{\cdot}58 \tan^2 \alpha}{\tan^3 \alpha}.$$

Other Factors

In addition to the bending moments and shearing forces considered in the foregoing paragraphs, the deflection of a dam depends on other mechanical factors also, chief among which are the non-uniform settlement of the foundation and the resistance afforded by the natural rock abutments (i.e. the horizontal-beam action). For the purposes of this paper, however, these effects (which partly neutralise one another) are relegated to the group of secondary influences, in precisely the same manner as the rigidity of the joints in truss deflections. Apart from these general factors there is also the effect of creep and plastic deformation, which would have to be considered were a more involved equation attempted, although there are reasons to consider their effects as only temporary and decreasing with time.

Verification by Field Observations

The concrete dam with a triangular profile is characteristic of modern design tendencies. We may, therefore, describe this design as a "standard" type. There are, however, in existence hundreds, if not thousands, of gravity dams, built to altogether different profiles. In order to show the general applicability of the simple formula developed in the foregoing paragraphs, a number of designs are selected, including the "standard" profile, and also various unorthodox shapes, and each of them is analysed below, according to the method of the mentioned formula.

We shall begin with the French "Barrage d'Eguzon" as a structure approaching as closely as possible to the "standard" type.

The following investigation is based on information about this barrage, as given in Mr. Coyn's quoted paper. As will be seen from Fig. 1, the profile is an almost perfect triangle, the material being referred to as "Beton de laitier et blocs."

The upstream and downstream batters are, respectively, 0·05 and 0·834, which means that $\tan \alpha=0{\cdot}884$. The height being 61·11m and the measured deflection 25mm, we find the equation for E is

$$E=\frac{\gamma H^2}{\Delta} \times \frac{1+\tan^2 \alpha}{\tan^3 \alpha}=\frac{1{\cdot}0 \times 61{\cdot}11^2}{25/1000} \times \frac{1+0{\cdot}884^2}{0{\cdot}884^3}$$

$$=384{,}000 \text{ tons/m}^2=38{,}400 \text{ kg/cm}^2.$$

This quantitative result is in sufficiently close agreement with the figures quoted earlier.

The same paper contains another example of more or less the same type of dam, the "Barrage du Crescent," but in that case the bases of the calculation are not as obvious as they are for the Eguzon dam, for the heights of the dam above the rock surfaces are not the same on each side of the profile (see Fig. 1). In fact, the rock surface on the upstream side is 3m lower than on the downstream side.

It is rather obvious that the width of solid material resisting the effect of the water pressure at, or about, the level of the upstream footing must, in this case, be infinitely great. It is therefore clear that the deformations taking place at that low level are insignificant and need not be included in the calculation of movement of the top of the dam.

Accordingly, we select as the theoretical

[5] *Annales des Ponts et Chaussées*, 1919, Volume II.

[6] Serge Leliavsky Bey, "Pore Versus Crack as Basis of Uplift Concept," Rep. 13, Third International Congress on Large Dams, Stockholm, 1948, page 2.

[7] Serge Leliavsky Bey, "Experiments on Effective Area in Gravity Dams," *Trans. Am. Soc. Civ. Eng.*, Vol. 112, 1947, page 486.

base level of the dam the downstream rock surface, and thus obtain

$$E=\frac{27\cdot5^2}{5/1000}\times\frac{1+0\cdot79^2}{0\cdot79^3}=496{,}000 \text{ tons/m}^2$$
$$=49{,}600 \text{ kg/cm}^2.$$

In this formula 5/1000 is the observed deformation in metres and 0·79 is the value of tan α. The result is again fully satisfactory.

It will be of interest to consider, next, a diametrically opposed type of design, viz. a characteristically unorthodox profile. As such, we may take as an example the old Solingen dam, designed and built by (and representing the ideas of) an earlier generation of engineers. As seen from Fig. 1 the section of this dam is anything but orthodox. It might possibly be described as "the nightmare of the student of modern dam engineering." Also, the structure is scarcely homogeneous in material; broken stone, brick, clinkers and many other materials were used in building it. This variety of substances leads us to anticipate a rather lower value of E than the normal.

Another point in connection with these old dams constitutes a difficulty in analysing their elastic behaviour. While they are, indeed, the first large masonry dams the movements of which have actually been recorded, the description of the methods used, as it appears in Professor Ziegler's *opus magnum*[8] (which was the "Bible" of dam designers some thirty years ago), does not allow us to place much confidence on the results obtained. The construction programmes of these works were usually planned in such a way as to ensure completion of the dams just before the arrival of the flood, so as to take, as soon as possible, full advantage of the storage project. Suppose, for instance, that the dam was finished on April 1st. The filling would then begin at once, and whilst the level in the reservoir rose, so also did the temperature. The result was that the downstream face was heated more than the upstream face, and this caused the dam to deflect upstream, particularly if it were slightly curved in plan. Since these movements counterbalanced the movement due to the elastic effect consequent upon a rising water pressure, the result of the measurements was frequently nil, which caused some engineers at that time to abandon completely the idea that deflections occurred and to conclude that dams were ideally rigid. Thus only if the observations with the same apparatus were continued systematically until, say, the end of January or February and the reservoir remained still full were the true elastic deformations observed.

It is therefore rather fortunate that such a complete diagram is available for the Solingen dam. It is reproduced in Fig. 2 from Fig. 345 on page 237 of Dr. Kelen's book, *Gewichtsstaumauern und massive Wehre*.

Reverting, for a moment, to Fig. 1, which shows the profile of the dam in question, our first problem is to find the relevant angle α. To accord with all that has been said on the approximate (but, nevertheless, practically significant) tendencies of this analysis, it is obvious that to solve the problem both the upstream and the downstream faces of the profile need to be replaced by average lines, from which the required value of α can be determined. This computation is shown in Fig. 1 and tan α is actually found to be equal 0·839.

Next comes the question of the water levels, as represented in Fig. 2. Attention is called to the fact that in both the cases thus far investigated, the zero point for measuring the deflections of the masonry was determined by the position of a point selected on the dam with an entirely empty reservoir. In the Solingen dam the conditions are, however, different, for there always remains in the reservoir (see Fig. 2) some amount of water, even when the level is at its lowest. It follows that, instead of varying from zero at the top of the dam to a maximum at its base, the water pressure varies from one level to another. It is obvious that the problem of interpreting deflections under these conditions differs substantially from the straightforward problems dealt with earlier.

The author regrets that he is unable to produce a simple formula conforming to these new conditions. The problem is in itself simple enough, theoretically, but the integration yields an equation with a large number of members, containing different powers and natural logarithms of the height, which are anything but easy to use in practice. The following simple solution is therefore suggested. In Fig. 3 he has produced a dimensionless graph, which gives the ratio of the minimum deflection to the maximum deflection (for reservoir full conditions) depending on the ratio of the minimum water depth in the reservoir to the maximum depth.

Thus the calculation of the deflection for any depth h in the reservoir can be done as follows: using the simple formulas which have been given earlier, calculate the full deflection corresponding to the maximum water depth H, and then multiply this result by the specific abscissa ϕ of the diagram 3, corresponding to the particular value of the ratio h/H calculated according to the required level h. This gives the true deflection, corresponding to the water level in question. The procedure will be better explained by application to the Solingen dam.

First, consider the highest level in the reservoir h_1 and calculate the corresponding deflection,

$$\Delta_1=\phi_1\frac{H^3}{E}\times\frac{1+\tan^2\alpha}{\tan^3\alpha}.$$

Then investigate the lowest level h_2 and find

$$\Delta_2=\phi_2\frac{H^3}{E}\times\frac{1+\tan^2\alpha}{\tan^3\alpha}.$$

Finally, subtract one formula from the other and, after transformation, obtain

$$E=(\phi_1-\phi_2)\frac{H^3}{\Delta_1-\Delta_2}\times\frac{1+\tan^2\alpha}{\tan^3\alpha}$$

in which ϕ_1 and ϕ_2 are the abscissæ of Fig. 3 corresponding to the ratios h_1/H and h_2/H

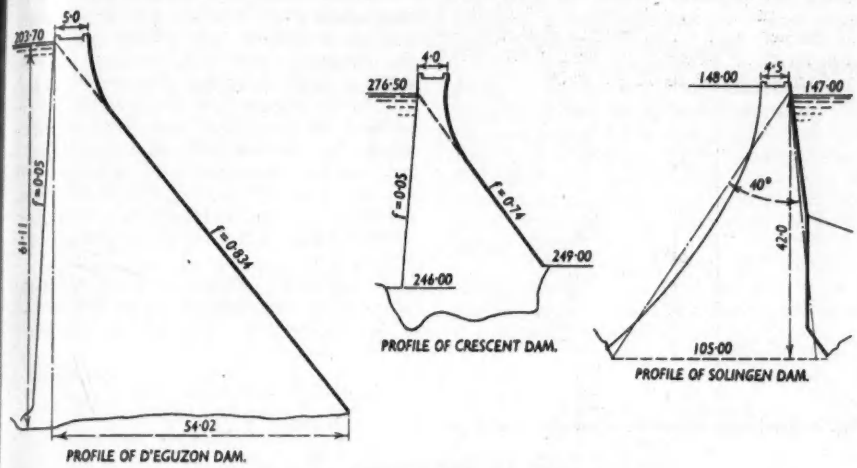


Fig. 1—Profiles of D'Eguzon, Crescent and Solingen dams

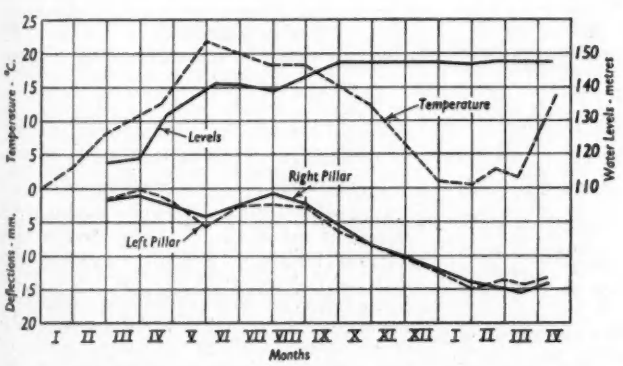


Fig. 2—Deflection diagram for the Solingen dam reproduced from Dr. Kelen's "Gewichtsstaumauern und massive Wehre"

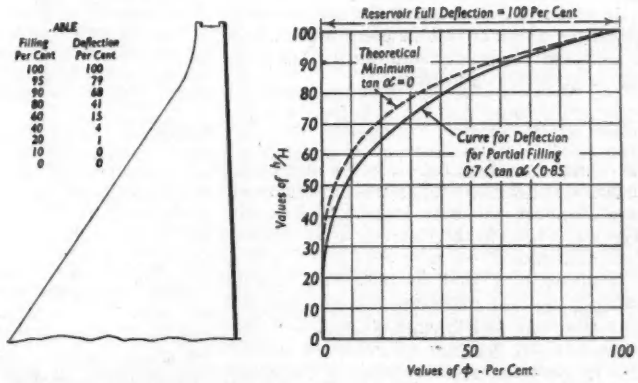


Fig. 3—Development of graph showing ratio of minimum to maximum deflection

[8] P. Ziegler, "Der Talsperrenbau," Berlin, 1927.

and Δ_1 and Δ_2 are the corresponding actually observed deflections.

In the case of the Solingen dam, according to Fig. 2, $h_1=H$ and therefore $\Delta_1=\Delta$. On the other hand, $h_2/H=12/42=28{\cdot}6$ per cent. Hence, according to Fig. 3, $\phi_2=2$ per cent It follows that

$$E=0{\cdot}98\frac{42^2}{15/1000}\times\frac{1+0{\cdot}839^2}{0{\cdot}839^3}=332{,}000\text{ tons/m}^2$$
$$=33{,}200\text{ kg/cm}^2.$$

This figure, taking into account the age of this dam and the nature of its materials, seems to be fairly reasonable, as compared with the figures obtained for more recent works, built according to modern specifications.

There is, however, one point in this calculation which possibly calls for fuller explanation, namely that the curves in Fig. 3 depend on the value of tan α. The reason for this interdependence is, of course, the fact that on the value of tan α depend the relative effects of the tangential stresses, as against the bending stresses. Whilst the former are proportional to the squares of the heights, the latter are functions of the cubes of the heights, and, therefore, if we imagine a dam with tan $\alpha=0$ (for instance, a dam built of interlocking sheet piling) the diagram representing the deflection of the top as a function of the water level in the reservoir is a convex curve (as shown by the dotted line in the chart in Fig. 3) ; but as tan α increases the curve gets flatter and flatter, so that for the usual values of tan α (i.e. from 0·7 to 0·85) the effect of α is almost negligible.

The conditions of the problem which have to be solved in connection with the Solingen dam may be briefly summed up as follows : we chose a point on the vertical axis of the dam (in fact, the top point on this axis) and we study the deflections of this point, as the water level in the reservoir is varying (i.e. rising or falling).

The next problem to be investigated seems somewhat similar, but is, in fact, basically different. We shall study the deflections at various levels of the axis whilst the reservoir remains full, i.e. using the common nomenclature of the theory of the strength of materials, we solve the problem of the elastic axis of the dam.

In view of the generally approximate character of the equations used in this study, a sufficiently accurate solution of this problem is given by the formula

$$\Delta'=\frac{\gamma}{E}(2Hh-h^2)\frac{1+\tan^2\alpha}{\tan^3\alpha}$$

in which (see Fig. 4) Δ' is the horizontal deflection of the vertical axis of the dam at the level h above the base level of the profile. The water level in the reservoir is assumed to be a maximum.

Suppose, now, that the pendulum used for carrying out the measurements is suspended in a drainage gallery at level h_2 above base level, and the readings are taken in a lower gallery at level h_1 above the same level, as shown, for instance, in Fig. 5. These readings will then represent the difference between the deflections of the axis, corresponding respectively to the levels of the two galleries. Hence

$$E=\frac{\gamma}{(\Delta)}[h_2(2H-h_2)-h_1(2H-h_1)]\frac{1+\tan^2\alpha}{\tan^3\alpha}$$

in which (Δ) is the observed deflection.

Owing to the confusing effect of seasonal thermal movements, which obscures the records of purely mechanical deformations, it is not easy to find a dam in which the conditions assumed in developing this formula are fully realised. The nearest to these conditions known to the author are those of the Vranov dam, on the Dyje, in Czechoslovakia, as described by Mr. Karel Lossman in Report R.8, in the proceedings of the Third Congress on Large Dams, Stockholm, 1948.

As will be seen from Fig. 5, which shows the overflow section of this dam, its total height is about 50m. But the measurements, whilst the reservoir was being filled, were

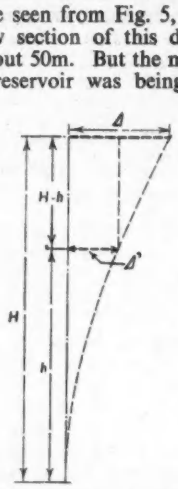


Fig. 4—Horizontal deflections of vertical axis of the dam

made by means of a pendulum which was only 33m high. It was, in fact, attached to the concrete in the upper gallery at 45·50m above foundation level, and the movements of its counterweight were micro-photographed at the level of the lower gallery, viz. at 12·50m above the base. Judging by the terms of the quoted report, it appears that the temperature effect was about as follows : in the overflow section, where the downstream face was at least partly cooled by the sheet of falling water, the recorded movement of the pendulum was 5·77mm, whereas in the bulkhead part of the dam, in which the downstream face was fully exposed to the

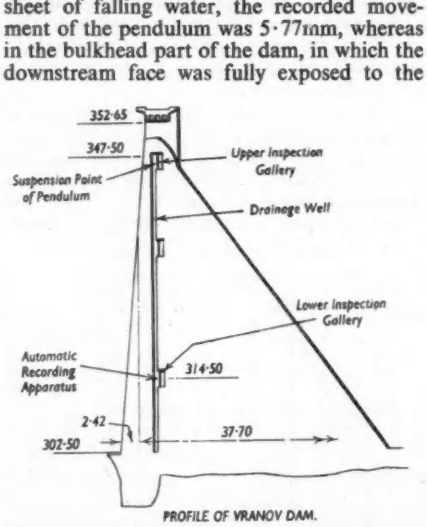


Fig. 5—Deflection measurements on Vranov dam

effect of the sun's rays, the movement was 3·46mm only, in spite of the fact that the pendulum employed in this second measurement was 4m longer. It is therefore obvious that the first of these two figures must be used in our calculations as the nearest to the free elastic movement of the dam, but it may not give the full value of this movement.

Another matter in connection with these measurements deserves to be mentioned also —the uplift. On several previous occasions[9] the author has expressed doubts as to whether the drainage schemes introduced into certain dams should be taken as significant design factors in calculating the stability of the respective profiles ; the chief reason being that some of the drainage wells are known to have gradually ceased to pass any discharge, which means that the pores around these shafts have been clogged by the minute solid particles carried by the water filtering through the concrete, and in such sections the relief afforded by the drainage scheme is therefore illusory.

On the other hand, the movement of the dam must be visualised as the result of average conditions, for a certain length of the structure, and it is obvious that the average uplift force for that length cannot fail to be affected by a drainage system, particularly in the first year of its existence, when the infinitesimal micro-passages in the concrete surrounding the drainage wells are still open. It seems, therefore, appropriate to use in analysing the movements of the Vranov dam the coefficient K_1, instead of K.

The value of Young's Modulus calculated under these assumptions from the formula of the elastic axis of the dam, is then found to be as follows :—

$$E=\frac{\gamma}{(\Delta)}[h_2(2H-h_2)-h_1(2H-h_1)]\frac{1+0{\cdot}58\tan^2\alpha}{\tan^3\alpha}$$
$$=\frac{1{\cdot}0\times1000}{5{\cdot}77}[45{\cdot}5(2\times50{\cdot}65-45{\cdot}5)$$
$$-12{\cdot}5(2\times50{\cdot}65-12{\cdot}5)]\times\frac{1+0{\cdot}58\times0{\cdot}792^2}{0{\cdot}792^3}$$
$$=568{,}000\text{ tons/sq. m}=56{,}800\text{ kg/cm}^2.$$

This figure is again very reasonable taking into account that the thin sheet of water falling over the dam could not have been fully effective in equalising the temperature in the concrete.

It will, of course, be realised that in attempting a formula for deformations, much care and discrimination must be used in the choice of field data which is to be employed for verifying it. For instance, taking the case of the Guerledan dam, in France, some inadequate observation methods used during the construction period are reported to have yielded a total deflection of 26mm. On the other hand, in accordance with more precise measurements made with the pendulum, Monsieur André Nizary, who reported the case, in 1948, to the Third Congress on Large Dams,[10] concluded that the original deformation was of the order of 12mm only. This figure must, however, be considered as an estimate only.

Substituting it in our formula we find :—

$$E=\frac{\gamma H^2}{\Delta}\times\frac{1+0{\cdot}58\tan^2\alpha}{\tan^3\alpha}$$
$$=\frac{1{\cdot}0\times44^2}{12/1000}\times\frac{1+0{\cdot}58\times0{\cdot}745^2}{0{\cdot}745^3}$$
$$=520{,}000\text{ tons/sq. m or }52{,}000\text{ kg/cm}^2.$$

This result seems to be fully satisfactory. Note that the coefficient K_1 is used in this equation instead of K for the same reason as in the Vranov dam.

No study on dam deformation measurements could be complete without a reference to the classical work of the Swiss engineers : "Mesures Observation et Essais sur les Grands Barrages Suisses," Bern, 1946. From the various examples quoted therein we may choose, for instance, the Garichte dam, for it seems to have been less affected by temperature than the other works described in this book.

Applying our formula to this dam we obtain :—

$$E=\frac{\gamma H^2}{\Delta}\times\frac{1+\tan^2\alpha}{\tan^3\alpha}$$
$$=\frac{1{\cdot}0\times33{\cdot}75^2}{9{\cdot}6/1000}\times\frac{1+0{\cdot}78^2}{0{\cdot}78^3}$$
$$=402{,}000\text{ tons/sq. m}=40{,}200\text{ kg/cm}^2.$$

[9] Serge Leliavsky Bey, "Structural Methods for Reducing Uplift and Leakage in Gravity Dams," THE ENGINEER, London, March 11, 1949, page 264.

[10] See *Proceedings* of the Congress, Report 34, page 19.

Most interesting additional measurements were carried out at the same dam, tending to show that the true elastic modulus was somewhat higher than the figure given above, but until more light has been shed on the question, whether these supplementary deformations are local or general—their interpretation is a matter of opinion.

Summing up the calculated values of E for the various dams investigated in the foregoing pages, the following table is obtained :—

Dam	Deformation, mm	Kg/cm²
Eguzon	25·0	38,400
Crescent	5·0	49,600
Solingen	15·0	33,200
Vranov	5·77	56,800
Guerledan	12·0	52,000
Garichte	9·6	40,200
Total		270,200
Average		45,000

The fact that the average value of E for the six dams investigated agrees almost exactly with the value obtained by the author for the Aswan dam (E=46,000 kg per square centimetre) may be a coincidence, but it still deserves mention !

Conclusion

The result of this analysis may, consequently, be framed by the simple formula,

$$\Delta=\frac{\gamma H^3}{E}\times\frac{1+\tan^2\alpha}{\tan^3\alpha}$$

in which E=450,000 tons per square metre, or its equivalent, in other units.

This formula gives the horizontal movement of the crown when the reservoir is filled from base to top level of the dam. The effect of partial filling can be estimated from Fig. 3, as explained for the Solingen dam. Deflections at intermediate levels may be calculated by means of the same method, which was used in connection with the Vranov dam.

No claim is made that the formula is ideally accurate, but it is believed to be at least as precise as the other, much more complicated, equations.

Production Exhibition and Conference

THE first Production Exhibition was opened at the National Hall, Olympia, by Sir Walter Monckton, the Minister of Labour, on Wednesday last, July 7th. This exhibition has been organised by Andry Montgomery, Ltd., and it is sponsored by the Institution of Production Engineers. It is designed to show means of improving industrial efficiency by exhibiting the equipment and methods by which higher outputs have been achieved by private firms. It also deals with the facilities available to industry and the work done by Government departments and research organisations to assist industry to attain higher levels of productive efficiency.

The Production Conference

A conference being held in conjunction with the exhibition also opened on Wednesday, when the Earl of Halsbury presented the 1954 Sir Alfred Herbert Paper of the Institution of Production Engineers. Lord Halsbury, in his paper entitled " Some Problems of Higher Technological Education," spoke of the vital part which production engineering played in the economy of the nation, and how the various forms of technical education contributed to the training of future engineers.

On Thursday, July 8th, three papers were read : " Productivity and National Resources," by Mr. D. Graham Hutton ; " Practical Applications of Production Engineering Research," by Dr. D. F. Galloway ; and " Production Engineering Research and the Information Services at Work in the Factory," by Mr. W. P. Kirkwood. To-day a paper " Simplification by Selection " is being read by Mr. S. J. Harley ; and at a session dealing with scientific research and the changing pattern of British industry Mr. H. Sutton will speak on " Materials for Gas Turbines " and Mr. W. A. Sales on " The Gas Turbine and the Production Engineer."

On Monday next, July 12th, the papers to be presented will be " The Trade Union Attitude to Research and Productive Efficiency," by Mr. James Crawford ; and " Standardisation in the Process Industries," by Mr. E. W. Greensmith. On Tuesday Mr. H. G. Wood will read a paper on " Introduction of Work Study into Smaller Firms," and at a session on standards for export three papers will be presented : " Standards in Electrical Exporting Industries," by Mr. D. Maxwell Buist ; " Packaging and Movement," by Mr. R. E. Huffam ; and " Work of the British Standards Institution as Affecting Export Trade," by Mr. H. A. R. Binney. The conference will close on Wednesday, July 14th, after the reading of two papers : " Human Factors in Technological Change," by Professor C. A. Mace and Miss B. Foyle ; and " It All Depends Upon Management," by Mr. F. C. Hooper.

The Production Exhibition

The exhibition is arranged in sections covering an introduction to productivity, scientific research and development, standardisation, the human element in productivity, new methods and processes in manufacture, aids to production, and materials, metals and developments.

The exhibit of the Department of Scientific and Industrial Research is designed to show to the industrialist the importance of organising his establishment for making the most effective use of new ideas. Means are shown how individual firms can keep in touch with technical developments and ensure that new ideas are developed and put into operation with a minimum of delay. Examples of discoveries which have led to industrial advancement are given and it is shown how their adoption has promoted economies in production and increase in output. A number of other research organisations also represented show their contributions to industrial advancements.

In the section on standardisation the British Standards Institution shows how the use of standards serve to simplify production, increase safety, improve standards of quality, assist exports, &c.

In dealing with the part played by the human element in productivity the Ministry of Education display shows the work of universities, technical colleges, technical schools, &c., as applied to training for industry, and the Ministry of Labour and National Service gives details of its services for placing young people in industry and advising employers. Other bodies represented in this section include the Tavistock Institute of Human Relations, the Industrial Welfare Society, the Institute of Personnel Management, the British Institute of Management, Imperial Chemical Industries, Ltd., and Aims of Industry, Ltd. Each of these bodies shows the particular work it does to increase productivity by promoting good industrial relations, improving working conditions, selecting and training personnel, &c.

Individual firms and Government departments have all contributed to the three sections of the exhibition dealing with new methods and processes, aids to production, and materials, metals and developments. Amongst firms showing instruments, methods and techniques for improving production are Alfred Herbert, Ltd., Taylor, Taylor and Hobson, Ltd., W. and T. Avery, Ltd., the Scientific Instrument Manufacturers' Association of Great Britain, Standard Telephones and Cables, Ltd., Servis Recorders, Ltd., Powers Samas Accounting Machines, Ltd., Kodak, Ltd., Hoover, Ltd., Lansing Bagnall, Ltd., the Rubery Owen Organisation, Black and Decker, Ltd., British Tabulating Machine Company, Ltd., Bakelite, Ltd., Climax Rock Drill Company, Ltd., &c.

An exhibit has been arranged by Joseph Lucas, Ltd., to emphasise the importance of specialisation in the toolroom ; it also shows machines for making armature sections to illustrate how an orthodox machine can be specially arranged for the production of precision ground parts. New methods of die construction are demonstrated by the company, together with press techniques which have made it possible to produce a component at each stroke of a press to give a much higher output than was attained with progressive or transfer tools.

The Ford Motor Company, Ltd., has taken equipment from its production line to illustrate some typical methods it has developed to increase output. One of the machines it shows in operation is the radiator core assembling plant, described in The Engineer for February 13, 1948, and which reduced the time required for assembling a core from 17½ minutes to 3½ minutes. Other machines include a piston lathe with a simple automatic loading and ejecting gear, and a needle roller assembly unit. A method of core moulding which has been adopted for producing valve rocker arm castings is also shown. In this method a resin/silica sand mixture is used to make the cores, the assembly of which is simplified by forming, in the process, male and female locators so that the moulding contours are accurately matched when stacked. For pouring purposes complete assemblies of twenty standard cores with top and bottom runner cores are clamped together.

The industrial applications of the gas turbine are shown by the Ministry of Fuel and Power, which has amongst its exhibits models of a coal-burning gas turbine locomotive, a peat-burning gas turbine, and a 1000kW gas turbine with air heater. An exhibit of particular interest on this stand is a fuel cell which produces electrical energy from chemical reactions without the intermediary of a heat engine.

The Ministry of Supply is showing some instruments and techniques it has developed which could be applied by industry to increase productivity. The working demonstrations on this Ministry's stand include a pair of automatic drilling machines designed and used in the Royal Ordnance Factory, Blackburn, for simultaneous drilling at fifteen points of holes of different diameters and not equally distant from each other. These automatic machines replaced three multi-spindle and six single-spindle machines and effected a reduction of 50 per cent in labour and production costs from the method previously in use.

From the Royal Small Arms Factory at Enfield there has been selected for demonstration a spring forming machine designed to form a complete spring at one setting and to perform in one operation the work previously spread over five operations. The action of the machine is a folding one from the centre of the strip outwards and in both directions at once. No drawing action takes place and the ends are automatically cropped to figure. This machine effected a saving of 93 per cent of labour costs. Other machines demonstrated include a vertical milling machine arranged for scroll cutting, and a lathe fitted with carbon dioxide coolant equipment. In co-operation with I.C.I., Ltd., demonstration tests are being given of " Sulf-Inuz " treatment, which imparts wear and seizure-resistant properties to steel and cast iron surfaces.

Six techniques developed by industrial concerns in conjunction with the Ministry's Directorate of Aircraft Production Development are also shown on static displays. These techniques include electro erosion machining, percussion machining, liquid abrasion, screw threading inserts and welding of plastics to dissimilar materials.

A display arranged by the British Electrical Development Association is designed to give a greater appreciation of the use of electricity in industry. A typical factory site plan shown with a planning model stresses the importance of efficient siting of plant to obtain maximum production. The use of electricity in materials processing and inspection is demonstrated with a mains frequency induction heating unit and a surface inspection panel.

Aluminium Strip, Sheet and Plate Mill at Resolven

No. I

At Resolven, in a valley a few miles inland from Neath in South Wales, a new mill for the rolling of strip, sheet and plate is nearing completion and is already in partial production. When it is in full operation, the new plant, which has been built for the South Wales Aluminium Company, Ltd., a member of the Tube Investments group, will produce a wide range of aluminium alloys ranging from commercial purity aluminium to high-strength heat-treated alloys in the form of circles, flat sheet, coiled sheet and corrugated.

THE choice of Resolven, near Neath in South Wales, as the site for the new aluminium rolling mill of the South Wales Aluminium Company, Ltd., was dictated by a number of factors, but perhaps that having the greatest influence was that the land had already been partly developed for another project concerned with aluminium. Before the war, in about 1938, Swiss interests planned to construct an aluminium reduction plant in Great Britain and a combination of circumstances influenced the decision to build at Resolven. Ports were available for the import of aluminium from European plants, there were adequate rail facilities and, at that time, that particular part of Wales was a distressed area. However, since cheap electricity is essential for the economic production of aluminium and since water power, the normal source of generating electricity at low cost, was not available, the primary factor in making the scheme a feasibility was the possibility of erecting a thermal electric plant, due to the presence of cheap coal.

This existed in the form of a large dump of anthracite duff which had no commercial value, but could now be burnt with a reasonable degree of efficiency. Water was available in sufficient quantities for there was surface water from a natural catchment area and a geological survey established the existence of an underground reservoir of ample capacity. The ground proved to be dry and of high load-bearing quality and the presence of a country house, designed by Nash, solved the problem of headquarters accommodation. The power station was built, but the outbreak of the second world war prevented delivery of equipment.

During the war the site was developed for the production of aluminium and provision made for the necessary electricity to be supplied from the grid to a transformer station which was built and in which three rotary converters were installed to convert to direct current at 32,000A and 400V. Two sheds were built, each housing thirty-four reduction furnaces, which were converted later to Soderberg furnaces, and metal was first tapped from the electrolysis plant in 1941 to produce virgin pig. As part of the plan a carbon plant was installed to produce the paste mixture required to make the furnace anodes, and another plant built to manufacture the pitch required as a paste binder. In association with this project a fume absorption plant was constructed, consisting of a soda lye washer, electrical precipitators and coke filters, to treat the fumes from the reduction furnaces and so prevent any harmful elements from passing into the air and affecting agriculture. Other ancillary equipment was installed and welfare buildings erected.

By 1942 a foundry had been added and was in operation, together with two concrete cooling towers, of Mouchel design, for dealing with the cooling water from the casting units, the reduction plant and the gas producer. However, within a short time the major production centre for aluminium pig had moved to Canada, where reduction plants were being developed primarily because of the very low cost of electrical power, and so in 1944 the electrolysis, carbon and pitch plants were closed down while the foundry continued to operate.

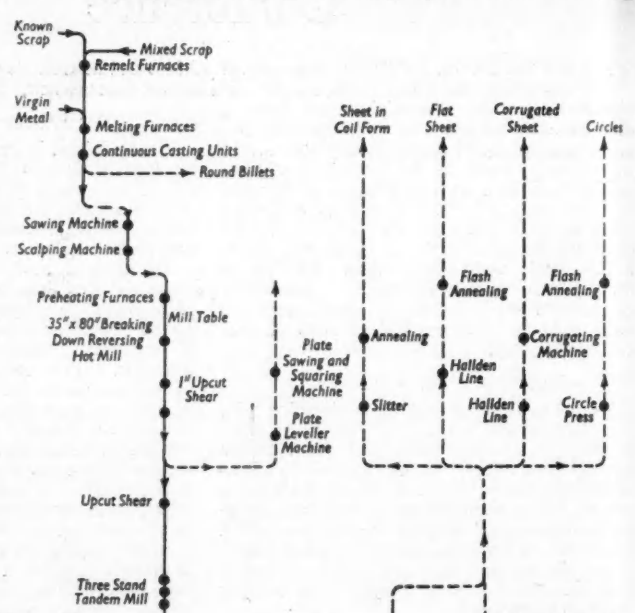
From the foregoing brief history it can be readily understood that the existing facilities offered sufficient inducement for Tube Investments, Ltd., to consider the building of the new mill, which the company had planned, at Resolven adjacent to the reduction works. Several other favourable factors were present such as the high load bearing characteristic of ground, which tests indicated to be of the order of 4 tons per square foot, so that no piling would be called for, while the contour map of the site showed that only a moderate amount of scraping and levelling, involving the minimum of excavation, would be required.

Buildings and Plant Layout

The site occupies an area of about 36 acres; the floor area of the old works amounted to 178,000 square feet, while that of the new mill totals 272,000 square feet. As designed, the rolling mill building is "L"-shaped, the short leg incorporating an existing building and the long leg consisting of three main bays and a lean-to motor house. Each bay has a span of 94ft 6in and measures 38ft 3in in height to the underside of the roof trusses, but they are of different lengths, being 835ft, 670ft, and 589ft, long respectively. Gantries are arranged to carry six 25-ton Clyde cranes and the main stanchions are placed at 32ft 9in centres along the length of the building. A north light design roof has been adopted and the trusses are arranged in the form of a lean-to with the long slope facing south and with the north end attached to the lattice girders which traverse the building at 32ft 9in centres, while the south end is connected with the bottom boom of the girders. To carry the glazing a secondary lean-to is arranged with one shoe connected to the top boom of the lattice girders and the other resting on the main lean-to. The roof of the main building is covered in Ruberoid steel deck, on the south slopes, with valley gutters formed by the steel deck, the valleys being filled with lightweight concrete covered with Ruberoid. There are two stretches of patent glazing, in the north slopes, carried in aluminium glazing bars. "Twin Twelve" asbestos sheets form the side cladding of the building in association with two stretches of aluminium alloy framed windows, having 100 per cent opening lights, above brick walls approximately 9ft high.

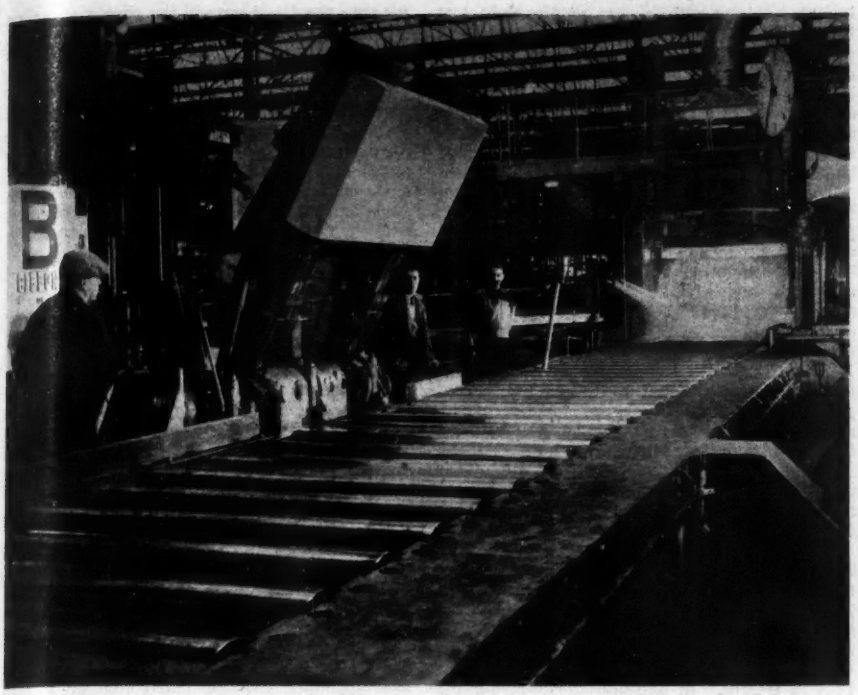
The main stanchions and lattice girders are arranged as portals and the steelwork, which weighs about 1600 tons, has been designed, fabricated and erected by Rubery Owen, Ltd. The lean-to motor house has a span of 45ft, is 458ft 6in in length, measures 25ft 6in up to the eaves and has a gantry for one 15-ton hand crane. Ruberoid covered troughed aluminium decking forms the roof of the motor house and is carried on aluminium alloy purlins and trusses. The floor of the mill consists of 7in thick reinforced concrete, using washed chippings as aggregate, with a hard-wearing, non-dust-forming, ½in thick surface cast monolithically with the base. Expansion joints are fitted between the main floor slabs which generally measure 30ft by 15ft.

From the accompanying diagrammatic flow chart the general sequence of operations can be followed. Process scrap is introduced with virgin metal to the combined melting and holding furnaces and is then cast, the round extrusion billets being sent to the company's associated plants while the rectangular rolling ingots travel to the sawing and scalping machines ready for loading into the preheating furnaces in preparation for entering the hot line of the mill. Here the slabs pass through a reversing two-high hot breaking down mill, followed by shearing and trimming operations. At this stage the plate material is taken away to be levelled and squared ready for dispatch, while the sheet continues to the three-stand tandem mill for further reduction before coiling. The coils are transported to the cold mills for further reduction either direct or via the annealing furnaces. There are three cold mills, namely two four-high non-reversing mills, one for roughing and one for finishing, and a two-high mill. According to requirements for the final product the material can pass through different mills or direct through the edge trimmer and slitter to the finishing lines.



Flow line diagram of aluminium strip sheet and plate mill

Scrap of known chemical composition is used in the melting furnaces in the foundry. There were originally seven coke-fired reverberatory furnaces, each of 6 tons bath capacity, which were converted to oil firing after the war. The new mill required a supply of large slabs, and to produce these a number of modern reverberatory furnaces, supplied by Gibbons Brothers, Ltd.,



Slab discharge machine which receives each slab from the preheating furnace, turns it over and places it on the hot mill feed table

were installed. They are designed for combined melting and holding, burning clean anthracite producer gas and preheated air. Some of the original furnaces with certain additions are still in use and are equipped with semi-continuous casting units for the production of extrusion billets. These units have a stroke of 60in and can cast solid billets from 6in to 20in diameter and hollow billets having a maximum size of 10½in inside diameter by 20in outside diameter.

There are four new furnaces in the shop, two of 20-ton capacity, each having a melting hearth to hold 13 tons and a holding hearth of 7 tons, and are capable of a melting rate ranging from 30 cwt to 40 cwt per hour. Between the furnaces are arranged the semi-continuous direct chill, hydraulically-operated casting units capable of casting slabs having a total weight of 6 tons per drop of ram. These multiple casting units are arranged in groups of two, three or five, the twin unit producing slabs measuring 50in by 10in by 13ft long, while slabs from the triple unit have a section of 38in by 10in and those from the quintuple group a cross section of 18½in by 5½in, the respective lengths being such as to give a total casting weight of 6 tons. The control of the ram drop is by means of a Weatherly oil infinitely variable speed gear and the rams move at speeds varying from 1in to 6in per minute, according to the particular alloy being cast. The second pair of furnaces also have a total capacity of 20 tons each, but have melting and holding furnaces of equal size. Casting units are placed between the two furnaces, but in addition there is another unit on the outside of the second furnace, which has been arranged for tapping at both ends. Another furnace, designed to tap at each end, is to be installed at a later date.

It is of particular interest to note that a very close check is maintained on the chemical composition of the alloy being cast, in that running samples are taken at the beginning, middle and end of the casting process and are prepared for analysis by "quantometer." This instrument, which is housed in a small specially designed room remote from the remelt shop, gives a rapid analysis of the samples taken and if any alloying element is off specification a warning is given by light signal and the pouring is stopped until the matter is rectified.

For handling the billets there is a traversing rail, fitted with a Coles hoist of 7·5 tons capacity, arranged to move along the length of the shop and to lock automatically with monorails sited over the casting units. The travelling rail then moves to the end of the shop, where the slab, which is in the vertical position, is lowered to a tilting section of a conveyor. This pivots to turn the billet to the horizontal so that it can then travel by gravity to the slab sawing and scalping shop. During its passage the slab is automatically weighed.

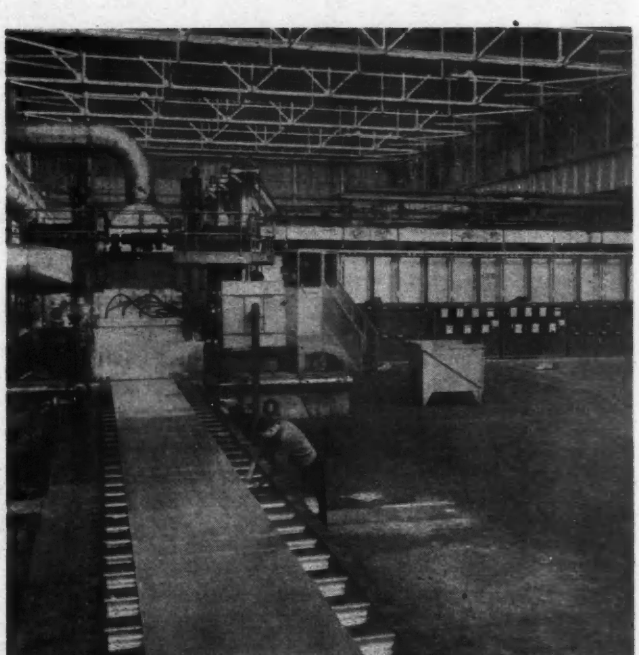
Over the discharge end of the conveyor is an *A* frame supporting a hoist which picks up the slabs and transfers them to one of three gravity conveyors along which the slabs roll under the span of one of the shop cranes. This crane has a span of about 60ft, a speed of travel of 300ft per minute and is equipped with a hoist which can lift 10 tons at 40ft per minute and traverse at 120ft per minute. Another crane of similar capacity and output also serves the shop, together with one to lift 5 tons, all three cranes being manufactured by the Clyde Crane and Engineering Company.

A considerable area of the bay is available for the storage of the cast slabs, and they are transferred to the Noble and Lund high-speed fluid feed cold sawing machine, which is to be duplicated later. The machine has a circular saw of 38in diameter, having periphery speeds of 1250ft and 2500ft per minute; the rate of feed of the saw ranges from 4in to 36in per minute, while the travel of the saw carriage is 5ft 9in. From the sawing machine the cut stock is stored ready for issue direct to the hot mill or is passed to the pair of horizontal scalping machines, which are placed in line complete with tippler gear. Each machine, manufactured by John Holroyd and Co., Ltd., has a dynamically balanced cutter, 51in in diameter, having a maximum peripheral speed of 6000ft per minute and set with sixteen roughing tools and two finishing tools. The drive is by a 70/35 h.p. two-speed squirrel-cage motor through vee belts, the final cutter spindle speeds being varied by changing the motor pulley to give cutting speeds of 2000ft and 4000ft per minute and of 3000ft and 6000ft per minute. The table, which has a working surface of 7ft 9in by 3ft 6½in and a traverse of 11ft 6in, is fitted with pneumatically-operated holding clamps and the feeds range from 10in to 60in per minute, there being a quick return of 20ft per minute.

The slab passes through the first machine, where the upper face is scalped and is then turned over in the tippler to continue to the second machine where the opposite face is scalped. Associated with these machines is a swarf conveyor supplied by the Darrold Engineering Company, Ltd. The swarf falls through slots in the chequer floor plates on to one of two cross vibratory feeder conveyors, about 10in wide by 9ft long, which deliver the swarf to the main overlapping tray conveyor placed about 2ft 6in below floor level. At a speed of 64ft per minute the conveyor operates between 50ft centres and rises to height of 6ft above floor level to deliver to collecting skips. At the delivery end of the conveyor is a high-speed rotating brush which prevents spillage, sweeps all the swarf into the skips and so ensures that the different alloys are kept completely separate.

From the scalping operation the slabs are taken to the charging conveyors, of which there are two, which consist of idler rollers on each side of a centre track driven by a motor through a Fluidrive coupling and a straight chain drive. Dogs at 162in centres engage behind the slabs, which are fed to roller sections under three overhead runways, supplied by Steels Engineering Company, Ltd., and equipped with 3-ton Matterson hoists. They transport the slabs to chairs on the loading table at the entrance of each of the two Gibbons preheat furnaces. Each furnace, which has a heating chamber 9ft wide by 5ft 3in high and a length of 63ft over end plates, is divided into five combustion zones separately fired by special burners in radiant tubes on each side and they can be removed to allow for operation by direct heating. Forced convection of the hot air is obtained by means of nine centrifugal fans in the furnace roof which drive the air around the radiant tubes in which gas is burned at 12in W.G. in air at 15in W.G.

There are charging and discharging tables with electrically-operated turning arms at each furnace which will heat twelve ingots measuring 38in by 8in by 50in, representing a weight of 1520 lb, in eight hours from 15 deg. to 520 deg.



Two-high 35in by 80in reversing hot mill, showing run-out table with the preheating furnaces to the right

Cent., when using producer gas having a calorific value of 143 B.Th.U. per cubic foot. Four sets of skid rails, one pair for each half of the furnace, take two lines of chairs representing two lines of ingots some 48in wide by 50in long, or one line up to 90in in length. The ingots are mounted in an upright position on the chairs and pushed along the skids by a screw and worm pusher gear, having a stroke of 2ft 6in and a speed of 3ft per minute. Each half of the furnace has cast iron counterbalanced doors which are interlocked with the pusher gear controlled by push button by the furnace discharge operator who starts the furnace cycle. The control opens the doors at each end and the charging and discharging tables turn through 90 deg., after which the pusher arm moves forward to push the chair and billet from the table into the furnace while at the discharge side the leading chair is pushed from the furnace on to the discharge table. After this the pusher retracts and trips a limit switch so that the tables at each end turn back through 90 deg. and the doors close. At the discharge end gibbets, carried on posts and automatically connected to the furnace cycle of operations, swing through 180 deg., lower to engage and pick up a chair which they raise, and swing through 180 deg. to deposit on the side return conveyors after which the gibbet returns to the top of the post.

Mill Hot Line

The heated slab is delivered to the slab discharge machine (illustrated on p. 47), and which is hydraulically operated and the maximum size of slab it can turn over measures 6ft 6in by 50in wide by 10in thick, and weighs 4000 lb, while the minimum size is 26in by 26in by 5in thick, the latter size being handled two at a time. The independent hydraulic system has a maximum working pressure of 1700 lb per square inch and special interlocked circuits to guard against hydraulic failure, while the machine embodies a link levelling mechanism. After being turned over the slab is deposited on the feed table leading to the 35in by 80in hot breaking down mill, which has been supplied, together with ancillary gear, by the Brightside Foundry and Engineering Company, Ltd. The feed table is 90ft 3in long and consists of fifty-eight cast iron rollers, 16in in diameter and 6ft long, and pitched at 19in centres. It is divided into four sections in each of which the rollers are driven by a 50 h.p. reversing motor through line shafts and enclosed mitre gears. All rollers and shafts run in ball or roller bearings. Besides the main ingoing table there is a 48ft long idler table for handling long pieces on the front side of the mill.

The two-high reversing, hot breaking down mill (also illustrated on p. 47), can roll at 476ft per minute and has forged steel rolls of 35in diameter by 80in long and 60/70 deg. Shore hardness, mounted in fabric bearings and is driven by a d.c. motor of 1800 h.p. (r.m.s.) at ±0/40/52 r.p.m., having a peak operating torque of 650,000 lb feet at ± 0/40 r.p.m. and a maximum emergency torque of 780,000 lb feet. A slab pattern universal coupling transmits the torque to double helical pinions and then by universal spindles to the rolls. Two reversing, 50 h.p. d.c. motors drive the screw down gear at a speed of 32in per minute in the downward direction and 47½in per minute upwards. Roll changing is effected by the withdrawal of the roll and chock assembly on slides by means of a motor-driven winch.

The mill is intended for the hot rolling of commercially pure aluminium alloys, including the heat-treated alloys, at a maximum temperature of 575 deg. Cent., and can handle slabs measuring 28in by 7in by 50in to 48in by 10in by 96in and ranging in weight from 980 lb to 4000 lb to give a reduction in thickness from 10in to 0·25in. In addition to supplying the mill the Brightside Foundry and Engineering Company, Ltd., was responsible for providing the electric drive; the manipulators for centring the pieces at the reversing mill and before they enter the finishing train; one 1in upcut shear; two ¾in upcut shears, and some 700ft of line and roller tables serving the hot mill and the finishing train and associated equipment.

From the hot mill the outgoing table leading to the 1in shears is 86ft 9in long and in four sections, each driven by a 50 h.p. reversing motor and fitted with coned rollers 16in in diameter by 5ft long, spaced at 24in and 19in centres. Between the 1in shear and the edge trimmer is a section of live table having 14in diameter rollers 5ft long pitched at 24in centres, while the approach table to the finishing train is 92ft in length with rollers of a similar size and spacing. From the finishing train the outgoing table is 38ft in length and has coned rollers 14in in diameter by 5ft long. After this there is a run-out table, leading to the second set of ¾in shears, having a total length of 240ft and equipped with 14in diameter coned live rollers at 4ft centres with intermediate tubular idler rollers of 9in diameter.

There are four pairs of manipulators for centring the piece on the roller tables, one pair at each side of the hot mill and the other two pairs sited 58ft apart on the approach table to four-high tandem mill. Each group of two pairs of manipulators is supplied from a self-contained pumping unit and the two pairs at the reversing mill are interlocked with the mill control so that they close or open according to the direction of the mill.

The power for the mill motor is supplied from a flywheel motor generator set consisting of one 1500kW (r.m.s.), 450V, 740/600 r.p.m. d.c. generator, driven by a 2500 h.p., 740/600 r.p.m., 6600V, three phase, 50 c/s slipring motor having a 12ft diameter flywheel weighing 9·5 tons and having a stored energy of 65,000 h.p. seconds at 750 r.p.m. There is also an auxiliary generator, for the live roller table and trimming shear motors, rated at 520kW (r.m.s.), 240V, 740/600 r.p.m. All the generators were supplied by the Metropolitan-Vickers Electrical Company, Ltd.

The movement of the slab is controlled from a pulpit at the hot mill by an operator who maintains control as far as the tandem mill. The peripheral speeds of the live rollers are electrically synchronised with the entry and delivery speeds of the mill and, when required, the rollers are arranged to run at speeds matching those of the trimming shears and upcoilers. The relationship between the entry and delivery speeds of the mill varies as the draught and the speed of the rollers at the entry side can be adjusted to 67 per cent of that of the delivery side. After the last pass the piece runs up to the

General view of the hot line looking towards the two-high hot mill and showing, to the left, the three-stand, four-high tandem mill. The preheating furnaces can be seen in the background

vee upcut shear and control is taken over by the finishing train operator and the speed synchronised with that of the tandem mill.

After completing the required number of passes the piece travels to the 1in upcut shear, manufactured by the Head Wrightson Machine Company, Ltd., which has blades of special steel 98in long by 6in by 1½in and cuts high-strength aluminium alloy plate up to ¾in thick cold or 1in thick at 300 deg. Cent., and up to a maximum width of 75in. The shear is capable of ten cuts per minute at maximum load. The piece moves on to the Loewy edge trimmer, of the adjustable housing design, which has 21in diameter cutters driven by a 125 h.p., 500/825 r.p.m. motor. It can deal with material up to ¾in thick and having a width varying from 27in to 70in. All the gears, with the exception of the main reduction unit, are enclosed in the heads, into which are built the two flying shear scrap cutter units which are motor adjusted for correct trimming width. The travel of the head allows them to be opened out clear of the roller track to allow plates up to 80in wide to run through to the finishing mill which is preceded by a Head Wrightson vee upcut shear. This machine is designed to cut high-strength aluminium alloy up to ½in thick cold and ¾in thick hot in widths up to 54in maximum, and is equipped with special steel blades 72in long by 3½in by 1in, having four cutting edges. The shear is capable of making twenty cuts per minute at maximum load and limit switches disengage the thrust-operated dog clutch to prevent double cutting. Bottom entry and exit rollers ensure that the material passes over the bottom blade without being scratched.

Plate material is pulled off the line over non-scratch rollers on to a stillage which is picked up by a crane, using a loading ramp and spades, and transported to a Chavanne Brun heavy plate leveller which can deal with plate ¾in thick having a tensile strength of 16 tons per square inch or ½in thick having a tensile strength of 19 tons per square inch at 45ft per minute. There are eleven rolls, 2500mm wide by 180mm diameter, arranged six on top and five on the bottom, which, together with associated support rolls, are driven through reduction gearing. After levelling, the plates are transferred by crane to a sawing machine, capable of taking plates up to 35ft in length, which can saw through ¾in thick high-strength aluminium alloy at 8½in per minute.

The Clyde crane serving the hot line has a span of 90ft, a lift of 29ft 3in and it can hoist 25 tons at 12ft per minute while the traversing speed is 60ft per minute and the speed of travel 150ft per minute.

For the hot reduction of pure aluminium and aluminium alloys, including heat-treated material, there is a three-stand, 17in and 42in by 60in, four-high tandem warm mill, supplied by W. H. A. Robertson and Co., Ltd., the temperature at entry to the first stand being 350 deg. Cent. The tandem mill can be seen to the left of our illustration on p. 48 giving a general view of the hot line.

This tandem train is capable of reducing pure aluminium and low-strength alloys from 0·315in to about 0·040in in one pass, and the high-strength heat-treated alloys from 0·276in to 0·118in. The rolls in each stand are similar, the work rolls being of chrome alloy forged steel of 65/70 deg. Shore hardness and 17in diameter by 60in face, while the support rolls are of special alloy cast steel of 55 deg. Shore hardness and 42in diameter by 60in face. The work rolls are carried in roller bearings, mounted in forged steel chocks, and there is a wedge adjustment between the work roll chocks and the horns of the support roll chocks to maintain alignment of the rolls and to give a certain amount of offset. Chocks for the back-up rolls are carried on tilting pads, which allow the roll to deflect under load, and the anti-friction white metal roll bearings, designed to take a total load of 1500 tons, are flood lubricated, the system being arranged so that the lubricating oil can pass straight through with the roll at rest.

Each stand is driven by a 1500 h.p. d.c. motor through a flexible coupling and a double reduction gear unit at the first stand and single reduction gearing at the second and third stands. Rolling speeds at the first stand are 0/200ft per minute, while the respective figures for the second and third stands are 0/420ft per minute and 0/500ft per minute, the motor speeds in each instance being 0/750 r.p.m.

The screw-down drive at each stand consists of two 30 h.p. motors driving through a worm gear and two stages of spur gearing, while a magnetic clutch connects the two motor shafts to ensure equal adjustment of both screws, the speed of which ranges between 3mm to 9mm per minute.

Withdrawal of the complete back-up roll assembly is effected by a sledge pulled by a wire rope operated by an electric winch which drives all three sets of gear through individual clutches. To change the work rolls a porter bar with a counterbalance weight is used to enable a crane to withdraw the roll. Oil to all stands for hydraulic roll balance is delivered at a pressure of 1 ton per square inch from an accumulator, having a ram diameter of 8in by 8ft stroke, supplied by two single-stage Mono-Radial pumps, each of 6·75 gallons per minute capacity.

Material up to ½in thick can be taken on the 16in diameter drum coiler, which is of cam-operated wedge design and can wrap up to 34in diameter; the cam also operates the gripper. A 450 h.p. motor drives the drum coiler through a flexible coupling and double helical gearing. Constant tension is maintained on the strip during the coil build up, and a belt blocker, which is only used for the thinner gauges when the gripper is not in use, is fitted for the initial wrapping of the coil round the drum. After the weight of the coil has been taken by a set of diabolo pattern rollers, carried on a hydraulically raised coil jack, and the outer bearing of the coiler has been swung back, a stripper plate on a jack carriage pushes the coil off the drum on to loading conveyors. Here the coil is weighed and wired up before moving to a tippler and along a slat conveyor ready for transportation by fork lift truck or a three-pronged lifting fork operated by overhead crane. When the drum coiler is not in use, it is bridged over by a light roller table, which matches up with the rollers carried on top of the blocker, to lead the strip into the roll coiler. This unit can handle material up to ½in thick by 52in wide, and has a pneumatically-operated tailing and coil-ejecting mechanism. Both the drum and roll coilers can be by-passed and the strip passed along to the ¾in upcut shear and upcoiler, which is driven at speeds equal to that of No. 3 stand of the tandem mill and can handle material up to ½in thick by 52in wide.

Two motor-generator sets, provided by Metropolitan-Vickers Electrical Company, Ltd., supply the three 1500 h.p. mill motors, each of which is supplied from a 1200kW generator. Two of the generators are driven by a 3200kVA motor, which also drives a 600kW generator for powering the live roller table. The other generator is driven by a 1500kVA synchronous motor designed to run at unity power factor and the same motor drives a 150kW generator supplying power to the coiler and upcoiler.

In association with the hot mill and the three-stand tandem mill there is a soluble oil system consisting of a 48,000-gallon tank split into two equal sections, one for each mill. The coolant is circulated to the mills by two Pulsometer horizontal centrifugal pumps, each driven by a 120 h.p. motor and capable of delivering 2000 gallons per minute against a pressure head of 60 lb per square inch. From the mills the coolant drains to glazed drain sumps and is passed by two Sulzer vertical-spindle pumps powered by a 51 h.p. motor and having a capacity of 2200 gallons per minute against a 60ft head, through a cooling tower to the supply tank. In the event of a breakdown of the main soluble oil supply an emergency supply tank provides a supply of oil sufficient to allow the mill to run down.

(*To be continued*)

Mechanical Engineering Building at University of Birmingham

LAST Friday, July 2nd, the new mechanical engineering building at the University of Birmingham was formally opened by Dr. J. B. Conant, United States High Commissioner for Germany, and formerly President of Harvard University. Subsequently he presented an address on " The Use and Abuse of History."

The new building, whose construction was begun in June, 1947, caters for some 100 mechanical engineering undergraduates, twenty-five research and post-graduate students, and about 440 undergraduate students from other departments of the University. The building consists of a three-storey frontage block, containing lecture rooms and staff offices ; a two-storey workshop block, and an extensive single-storey laboratory block. While the workshops thus directly adjoin the frontage block, a structural

Fig. 1—The general drawing-office has a " laylight " ceiling constructed of thermally insulating glass

separation has been contrived to eliminate any risk of transmission of noise and vibration into the lecture rooms. The construction of an adjoining building of similar size and arrangement, planned for the Department of Electrical Engineering, has already been begun.

The building contains a large lecture theatre, which has a seating capacity for 300, and is fully equipped for sound film projection, and adjacent lecture rooms, of 130 and seventy-five seating capacity.

There is a library, supplementing existing sections of the main University library. It has a capacity of some 3000 books, and it will provide for the needs of the departments of mechanical engineering, electrical engineering and engineering production.

Accommodation on the second floor of the building is mainly in the form of drawing-offices, the largest of which (Fig. 1), measuring roughly 94ft by 75ft, caters for classes of up to 110 junior students. In addition to side windows in this office, an excellent degree of natural lighting has been ensured by means of a "laylight" ceiling, constructed in thermally insulating glass of opalescent quality, having a normal clerestory lantern light above. Artificial lighting is provided mainly by tungsten fittings of inexpensive industrial type housed inside the lantern space, giving the effect of a uniformly luminous ceiling : this is supplemented to a minor extent by fluorescent lighting on the perimeter ceiling bounding the actual "laylight." The senior students of the department have a separate drawing-office, measuring 83ft by 31ft, in which the more elaborate design work of the final year studies is carried out. An additional small office houses six representative modern drafting machines, upon which all senior students are instructed, while a sales room facilitates the supply of all necessary drawing materials to students. Modern equipment for dye-line printing has also been installed ; apart from its value to the staff, this equipment is demonstrated fully to students in order to emphasise the necessary qualities of tracing technique.

The upper floor of the workshop block (Fig. 3) contains a large variety of the lighter machine tools, and also fitting benches. Serving this floor is a 2-ton mono-rail system, which communicates with the lower floor through a large loading hatch. The lower shop, served by a 3-ton gantry crane, naturally houses the heavier machine tools—these being mounted on two continuous concrete monoliths running the whole length of the shop, while a section is devoted to light smithing work, heat-treatment and sheet metal work. A small basement beneath this block serves as a materials stores, while tool stores and a measurements and standards room are elsewhere provided.

The single-storey laboratory block consists essentially of a group of three main bays, flanked by a boiler-house. Each of the main bays measures 100ft by 40ft, and has a barrel-vault roof of reinforced concrete construction which incorporates a large clerestory light. These vaults spring from massive reinforced concrete beams which have a free span equal to the length of the bays and carry the entire roof load ; 11in brick cavity walls built up to the underside of the beams separate the three bays. But these walls are non-structural and thus provide for the possibility in the future life of the building for easy rearrangement of partitioning.

Fig. 3—The workshop on the upper floor contains a variety of lighter kinds of machine tools and fitting benches

A sub-floor of 4ft 6in headroom lies beneath the working level of the laboratories, and contains all pipe services, drainage systems, &c., giving the advantage of a clean and unobstructed layout on the working level. Cement-asbestos exhaust mains, serving all internal combustion engines, are included in this arrangement, the exhaust gases being extracted by a fan and ejected finally into the boiler-house chimney, which has a special internal division for the purpose. All those engine cooling circuits which are immune from contamination by grease or smoke are supplied by a recirculation system ; water falls by gravity head from 50,000 gallons capacity tanks built into the roof space of the frontage block, and, after use, collects in tanks in the sub-floor to be recirculated by vertical spindle pumps back to the roof level. A fully automatic float-switch control system is used which, apart from dealing with the normal recirculation process, actuates motorised valves to admit make-up water as required.

The boiler-house contains a modern Babcock and Wilcox water-tube boiler of 5000 lb per hour steaming capacity at 200 lb per square inch. The plant is fully equipped and instrumented for students' tests. The boiler-house structure includes also a small fuel testing laboratory and a gas producer house. The main laboratory bay adjoining the boiler-house is reserved primarily for use by junior students (Fig. 2). This bay contains steam plant in the form of two kinds of reciprocating engine, a Parsons experimental reaction turbine and a Belliss and Morcom experimental impulse turbine ; a two-stage air compressor, a horizontal gas engine equipped for operation either by town gas or producer gas, a modern horizontal oil engine and a vertical oil engine arranged for either blast or solid injection.

The central laboratory bay is allocated to senior undergraduate and post-graduate students, and contains a large variety of modern high-speed internal combustion engines, together with such specialised equipment as a Ricardo variable-compression oil/petrol engine. Also included is a carbon dioxide refrigerating plant and a modern Freon-12 plant, which can be operated under conditions representative either of refrigeration or of space warming. The remaining bay is reserved for research work and for further experimental work in the Post-Graduate School of Thermodynamics.*

In recognition of the growing indispensability of electronic gear to the mechanical engineer, an electronics laboratory has been incorporated on the ground floor of the frontage block. Provision is thus made for the maintenance and development of such apparatus within the department itself.

The department of engineering production created in the University a few years ago is housed largely in the frontage block of the new building. Accommodation includes a production planning drawing-office, a work study laboratory, and an elaborately equipped metrology laboratory with an adjoining vibration-proofed constant-temperature room, in which both temperature and humidity are controlled within fine limits to give the necessary operating conditions for highly delicate measuring apparatus. There are also provided a film analysis room, in which cinematographic techniques of micro-motion study are demonstrated, and a machines research laboratory in which projects such as those currently related to grinding and tool cutting are carried out.

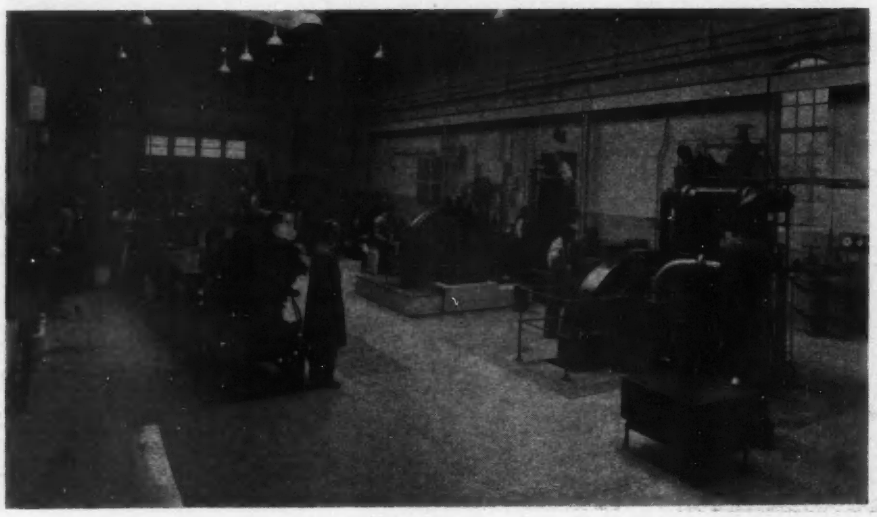
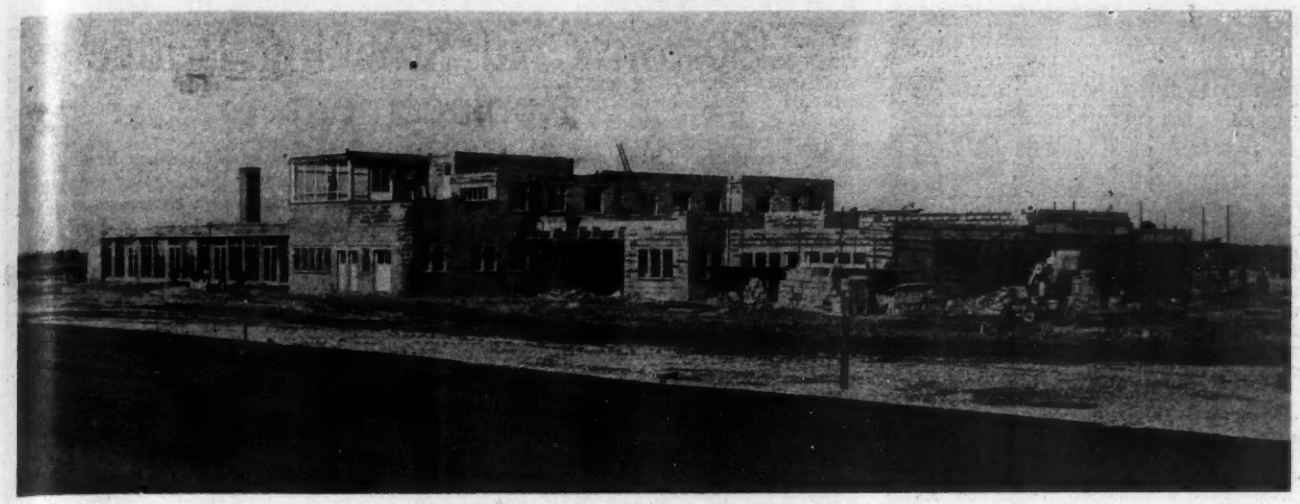


Fig. 2—The main laboratory bay is primarily reserved for the use of junior students

ASLIB CONFERENCE.—The twenty-ninth annual conference of Aslib is to be held at Church House, Westminster, London, S.W.1, from Friday to Monday, September 24th to 27th, under the presidency of Miss Barbara Wootton, whose address is to be entitled "Further Problems of Communication." The subjects for discussion at the conference include : the scientist as information officer ; equipment of current interest to information workers and librarians ; the theory of communication, and the function of the library in preparing and producing technical papers. Full particulars of the conference are available from Aslib, 4, Palace Gate, London, W.8.

* See THE ENGINEER, April 16th.



External work on the terminal buildings nearing completion, as seen from the apron

Ferryfield Airport

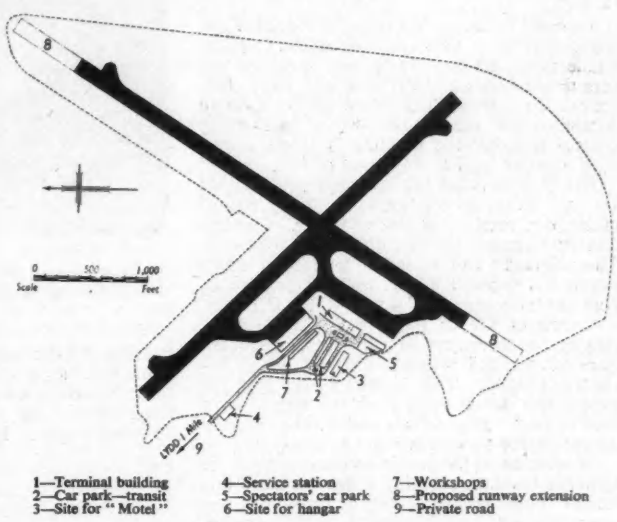
THE first British airport to be designed and built by an independent airline has now been completed at Lydd, near Dungeness, in Kent, and is to be officially opened on July 13th. From here Silver City Airways, Ltd., which has hitherto used the nearby State-owned Lympne airport, will conduct its cross-Channel air ferry services. The airfield and its associated administration buildings, which is to be known as Ferryfield, have been built by Richard Costain, Ltd., in just over six months at an estimated cost of £250,000. Its site stands on the Romney Marshes area and occupies about 246 acres.

It will be recalled that the company inaugurated this service to Le Touquet on July, 1948, using one aircraft—a Bristol "Freighter"—with which, by the end of that season, it carried seventy cars. Such has been the expansion of this ferry traffic that last August alone 13,000 vehicles were flown across and during that year a total of 39,000 vehicles and 96,000 passengers were handled on its various cross-Channel routes from Lympne. With its present fleet of fifteen Bristol "Freighter" and "Super-Freighter" aircraft, and a prospective peak aircraft movement of one every two minutes, it had become clearly evident that the facilities at Lympne were inadequate. Furthermore, the companies' operations were frequently interrupted by bad weather conditions. As a consequence of its elevation of 350ft it was often harassed by the cloud base, there were no runways, and it was frequently waterlogged.

There was no suitable nearby alternative airport nor any former wartime field which might be rehabilitated, and one of the deciding factors in the choice of the present site was the fact that it must lie no further from Le Touquet than Lympne. At the same time, although the terrain presented several problems in the realm of soil mechanics, it had many other important advantages. The area is very flat and almost at sea level, it has a good weather average—these being factors which provide natural safer approach and landing characteristics than on many other airports in the country.

The airport comprises two hard runways, an administrative and terminal building, car parks, workshops, service station and licensed bar and restaurant. Ultimately hangars will be added to permit part of the aircraft maintenance to be transferred from the company's present overhaul base at Blackbushe.

There are two hard surface runways in the conventional "X" form. The principal runway is 120ft wide and gives an effective operational length of more than 4050ft. The second runway gives an effective length of 3500ft. The runways have been built to their present lengths solely to suit the operation of the Bristol aircraft used on the air ferry service, but there is space for



1—Terminal building
2—Car park—transit
3—Site for "Motel"
4—Service station
5—Spectators' car park
6—Site for hangar
7—Workshops
8—Proposed runway extension
9—Private road

Arrangement of Ferryfield airport

A heavy steel vibrating sledge, driven by a 15 h.p diesel engine being used to consolidate the fill

1½in "Tarmac" carpet being laid over the stabilised gravel runway surface seen on the right

extensions to serve other operational requirements.

Construction of the Runways.—The runways are largely composed of shingle and gravels found on the site. These materials were mostly deficient in fine material and some contained excessive clay, but an adequate quantity of clean gravel was found which contained sufficient sand to be suitable for stabilising with cement. The selected material was spread as a 9in layer and 7 per cent cement incorporated by a single-pass stabiliser to give a finished compacted thickness of 6in. Where the runway cut through shingle ridges the 6in of stabilised gravel was laid directly on the shingle subsoil, but where the runway was underlain by clay a gravel base not less than 27in thick was constructed. A total of about 250,000 cubic yards of clay and other material was excavated.

In areas where abrasive action by aircraft is likely to be excessive the stabilised pavement is covered by 1½in of tarred stone. The main landing and take-off portions of the runways are sprayed with two layers of tar and gritted with fine sand and small stones. The airfield has no special drainage system, but where existing ditches cross any of the works they are carried in concrete pipes. A number of vertical drains were also constructed to pass water through the clay layer in places where there was any risk of local surface flooding. The tarmac area is in the western apex formed by the intersection of the runways. It faces the terminal building and has parking accommodation for six Bristol "Super-Freighter" aircraft; permanent "tie-down" points are sunk into the concrete. Normally aircraft will complete their landing run within a few yards of one of three taxi strips leading to the tarmac.

Terminal Building.—All the administrative and traffic facilities of the airport, as well as Customs and immigration formalities, will be carried out in a single building, 300ft long and 100ft deep. Except for a two-storey centre section housing administrative offices and radio and flying control sections, the building is single storey, with a ceiling height throughout of 10ft.

The building is divided into three main sections by two covered roadways for cars, motorcycles, &c., arriving or leaving by air. Customs and immigration offices adjoin these roadways. The passenger and reception lounge, to which passengers proceed on arriving at the airport, contains traffic counters, A.A. and R.A.C. offices, a branch of Lloyds Bank, and a small shop. Adjacent to this reception hall is a snack counter, licensed bar and restaurant served by an all-electric kitchen. The restaurant will seat 100 people and is separated from the tarmac by a wall of glass. Beyond this wall will be an open-air restaurant as well as a public enclosure.

In addition to the public accommodation, the terminal building contains a bonded store and freight transit sheds, as well as operations and crew briefing rooms, meteorological section, staff dining room, &c.

Flying Aids.—The airport will have comprehensive radio and airport aids.

Communications equipment includes a Decca 424 airfield control radar, an m.f. directional beacon, as well as three v.h.f. radio transmitters and three receivers, which will provide continuous communication between flying control and aircraft. Certain of the company's airfield transport will also be fitted with v.h.f. radio to provide instant communication with the control tower.

The Decca radar, which is capable of locating and identifying aircraft up to 16 miles away, provides an important additional safety measure, in particular for bad weather operation. A similar aid is shortly being installed at Le Touquet, the French terminal of the service, which will in effect give the flying controllers at both terminals the ability to "track" Silver City aircraft over the greater part of their short cross-Channel routes. The night-flying equipment includes a sodium-light funnel. Flying control at Ferryfield will be linked by teleprinter directly to the Ministry of Transport and Civil Aviation's "master" flying control unit at Uxbridge. Other teleprinters will link the airport with Lympne and with the company's London headquarters.

450-ton Coal Stocking Bridge Replacement

A complicated piece of work recently carried out by Fraser and Chalmers Engineering Works called for the re-alignment of a coal stocking bridge, weighing some 450 tons, at the Barking power station. Here some particulars of the complications involved in the job and the methods adopted to restore the bridge are outlined.

THE outside erection department of the Fraser and Chalmers Engineering works of The General Electric Company, Ltd., recently completed the unusual and complicated task of re-railing an electrically-operated travelling coal stocking bridge weighing some 450 tons at the Barking power station of the British Electricity Authority. This structure is of a conventional shear leg/needle leg design with equalising beams fitted between the bridge pivot points and the 16-wheel bogies. It has a 200ft span between the centres of the two 4ft 8½in gauge tracks, on which the bogies run. The structure carries belt conveyors, two large electric grabbing cranes and receiving hoppers which operate over the whole length of the top chord.

For reasons not yet fully explained, the bridge became mal-aligned to such an extent that the north and south bogies were 12ft 4in out of alignment, with the result that the south-east bogie equalising beam was forced completely out of its bearings and lay on its side, as shown

Fig. 1—Shear leg end of south bogie showing the south east compensating beam lying on its side with the ball and pin bearings out of their sockets. In the background the south west compensating beam can be seen inclined towards the pump house

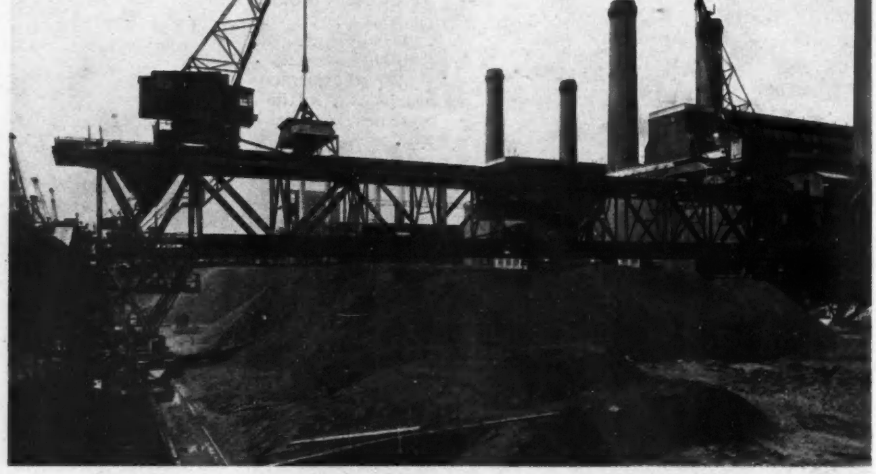


Fig. 2—Stocking bridge as restored to its operating state

in Fig. 1 opposite. The south-west equalising beam was thrust southwards, and the north end needle leg 3ft 6in out of vertical, as can be seen in Fig. 3. The whole structure had slipped 3ft 6in to the south and dropped 3ft at the south-east corner, the end structure being within inches of the main pump house for the station.

This briefly, was the problem which faced the company's engineers when called upon to inspect the situation. As the whole structure was entirely without the designed stabilising features of its shear leg pivots, it was in a most dangerous condition, with no indication as to what was preventing it actually crashing to the ground, particularly when the first operations of restoring it were commenced. On examination it was found that no steelwork members had failed, although certain compression members had buckled, no rivets appeared to have sprung, and both of the 16-wheel bogies remained on their respective tracks. The first essential was to ensure that no further movement could take place and two supporting piles of timber were erected beneath the bridge and chocks used to lock the bridge and the timber.

Fig. 3—North end needle tower pulled 3ft 6in out of its vertical alignment

A number of possible means for restoring the bridge were examined by Mr. W. S. Read, manager of the Fraser and Chalmers outside erection department, among them being the use of the giant P.L.A. floating crane. It was discovered, however, that with this machine by the quayside, the jib would be unable to reach far enough to secure a purchase and to make a lift from above the structure.

After due consideration it was concluded that the only means of securing adequate purchase was to lift with jacks, and here again a further complication arose. The site plan of the power station showed that, apart from the proximity of the pump house to the mal-aligned bridge, the main cooling water culvert for "B" and "C" stations ran beneath the most obvious point for applying lifting tackle.

It was essential, therefore, that the weight of the bridge be spread as evenly as possible to avoid any damage to this culvert since such damage would have had the effect of shutting down both "B" and "C" stations, an eventuality which it was, of course, impossible to entertain.

The erection of the timber trestling to secure the bridge took some three weeks but the operations finally involved in restoring the structure to its correct position required only ten days. With the assistance of the B.E.A's consultants, Merz and McLellan, Ltd., hydraulic jacks of 100 tons capacity each were obtained, and the timber was then removed from the piles supporting the bridge and four jacks inserted between the tops of the piles and the tension member of the bridge. Some supporting girders were introduced between this tension member and the top member to avoid undue stressing. Pressure was applied and after initial settling a lift was obtained which had the effect of moving the structure away from the pump house and in the correct direction. Further jacks were then brought into effect on the shear leg side to exert a lateral pressure across the tracks and by adjusting their action a combined lifting and lateral restoring movement was obtained. After four days of this procedure the bridge was only some 4ft out of lateral alignment. Some lower bearing structures were next cut out from the gantry, and then further pressure was applied with the object of obtaining alignment of the quayside compensating beam pivot and pin. By introducing pressure from further jacks and utilising the rail head and wheel flanges to obtain a rocking motion, the compensating beam was approximately aligned two days later.

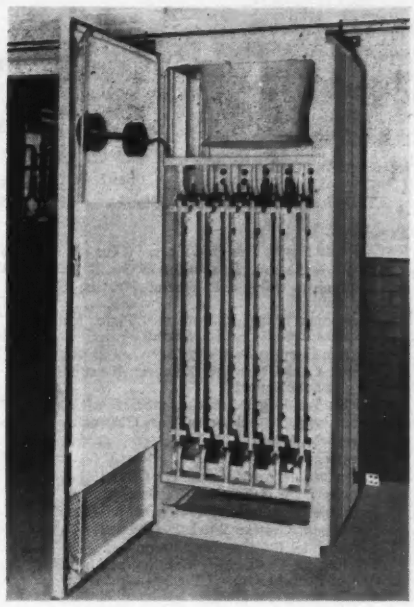
In view of the weight and unwieldy nature of the structure and the complicated operations involved it is to the credit of the engineers responsible that the cycle of operations took place on site as planned, and that no unexpected incidents occurred once the operation of restoring the bridge to its proper position had begun. An idea of the nature of the difficulties involved in this task may be obtained from the fact that there was no known precedent upon which to base calculations for restoring the bridge; also, whilst the work was in progress it was essential to maintain existing services through the coal handling plant which was in operation and feeding the stations. A further complication was the necessity to protect both the main pump house and the culvert from any damage which might have resulted in the loss of supply from these two essential stations.

After the operations of salvage were completed, examination of the bridge confirmed that there were no serious defects in the structure as a whole, and to enable the plant to resume operation, it was only necessary to replace certain members which had buckled and the one or two which had been removed to facilitate lifting.

Germanium Power Rectifier

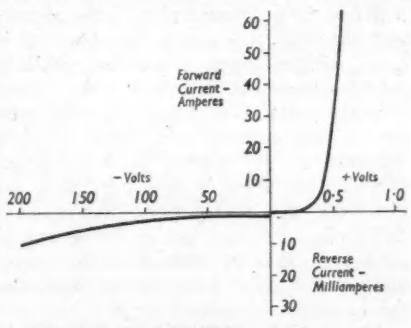
WE learn that on December 21, 1953, the British Thomson-Houston Company, Ltd., put into service in the firm's Rugby works a germanium rectifier rated at 300kW, 1100A. This installation is believed to be the first application, outside the U.S.A., of germanium to the problem of power rectification; with it a new rectifier, characterised by very high efficiency, enters a field normally covered by mercury vapour devices, contact rectifiers or rotating machinery.

This development is one of the results of many years' research on semi-conductors, and the production and processing of silicon and germanium crystals. For some time the B.T.H. organisation has been working on the production of a germanium rectifier equipment capable of carrying much heavier currents than previously; as a result the current obtainable from a germanium "cell" was increased from a fraction of an ampere to 50A. The next step was to design and build an equipment capable of rectifying 1100A at approximately 270V and this equipment was put into use in the Rugby factory about a year after the beginning of this development programme. A view of the 300kW rectifier cubicle with the door open to show the assembly of germanium rectifier cells is reproduced herewith. The rectifier operates on an electrolyser and has been in practically continuous service since the third week in December, 1953, on loads varying up to its maximum rating. The efficiency of the equipment is 98·5 per cent and it is considered that further equipments will show a better performance.



300kW germanium rectifier cubicle showing interior assembly of germanium cell

Day-to-day experience with the installation is being recorded; but it is pointed out this development is not yet sufficiently advanced for germanium to be used widely for power rectifying devices. The company proposes to produce units of new design and different capacities, at the laboratory stage, and to examine the suitability of germanium as a rectifier for different kinds of service. A second unit on a different sort of service will be installed shortly in the company's works, and it is hoped that during the coming year two more equipments will be installed for trial in more severe service conditions. The rectifying units for each of these will be produced in the laboratory.



Characteristics of "GJP" germanium power rectifier at 20 deg. Cent.

The current/voltage characteristic curve of a 50A rectifier unit built in the B.T.H. research laboratory is shown in the accompanying diagram. It will be noted that at currents of 50A the voltage drop is less than 1V.

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ROYAL SHOW AT WINDSOR

This week the Royal Agricultural Society of England has been holding its annual show in Windsor Great Park, by the gracious permission and under the presidency of Her Majesty The Queen. On an excellent site covering more than 150 acres, there has been arranged an exhibition which depicts just about every aspect of agriculture, Britain's oldest industry. It is, moreover, an exhibition in which the traditional art and craft of the countryside are skilfully blended with modern scientific farming practice. That, of course, could be said about every similar show which has been held since the formation of the Royal Agricultural Society 115 years ago. But the "Royal" is a mobile show; each year it is held in a different part of the country, with the result that a large proportion of its many visitors come from the particular neighbourhood, in which it takes place, although many, too, come from every other part of the country and from overseas. Windsor is the nearest point to London at which the show is now ever held, and this week, no doubt, more than usual of those who work and live in the metropolis have been able to increase their appreciation of the extent and scientific nature of this country's agriculture.

At the "Royal" visitors can admire the fine specimens of horses and cattle, whose appearance changes little with the years; they can watch, maybe a little enviously, the skill and dexterity of farriers, hurdle and gate makers, wrought iron workers and other rural craftsmen; and they can inspect a great array of machines, implements and other engineering equipment which has become, in a very few years, such an essential requirement of efficient farming. Naturally, it is with the engineering section of the Royal Show that we are most concerned, though we readily acknowledge that during our visits we have paused to take note of the many interesting items in other sections. The display of machinery and implements, however, which takes up the larger portion of the show ground, is a timely reminder that agricultural engineering—in which must be included design and development as well as production—is making an increasingly significant contribution to the progress of the engineering industry in general. It is fifteen years since last the Royal Show was held at Windsor. On that occasion, July, 1939, which marked the centenary of the Royal Agricultural Society, this country's agricultural engineering industry was only just beginning to recover from the setbacks that it suffered after the first world war. It was operating in keen competition with the American continent, and many farmers continued to be sceptical of the benefits to be derived from mechanisation. At that time, also, the use of the agricultural tractor had been by no means fully exploited, and for the most part the tractor was still looked upon as a useful, though not always economical, substitute for the draught horse. But almost before the last traces of the centenary Royal Show had been removed from Windsor Great Park, this country had been plunged into the second world war. The need for more and more home grown food quickly became apparent, derelict acres had to be reclaimed and land which had lain idle for years had to be rendered fertile in the shortest possible time. To say that the exigencies of the second world war alone were responsible for speeding up the progress of mechanised farming might be a little wide of the mark; yet this country's agricultural industry could never have accomplished what it did in those grim years had it not have had the ready help of agricultural engineers.

In the post-war years the mechanisation of agriculture has more than proved its value to the nation. The machines and implements which engineers have designed and produced have not only speeded up the performance of many farming operations, but they have also eased the wearisome toil hitherto associated with many of those operations. It has never been claimed for agricultural machinery that it can make two blades of grass or two ears of corn grow where one grew before, but it can be claimed that it has been the means of improving very considerably the productivity of one of our staple industries. In so doing, agricultural engineers to-day may justifiably feel some measure of satisfaction that their work has been and continues to be beneficial in a world where the production of sufficient food for a growing population continues to be a pressing problem. Furthermore, the technical progress during the last decade in farm machinery design and production has a commercial aspect which is of considerable value to the present state of the nation's economy. Last year, for example, the value of the agricultural tractors and other machinery produced for home use amounted to about £45,000,000, while the value of tractors and machinery sold abroad by this country reached a figure approaching £50,000,000. A survey of this year's Royal Show certainly helps both the expert and the casual visitor to see more clearly the significance of these matters. The Royal Agricultural Society of England merits the congratulations of engineers, farmers and of the general public for the way in which it continues "to encourage men of science in their attention to the improvement of agricultural implements," as set out in its charter granted 115 years ago.

TECHNICAL EDUCATION IN THE COLONIES

Given that in starting up a new technical college it is intended as soon as may be to widen its fields of study and to aim at the attainment of university status, one thing seems manifest to an inhabitant of so fully industrialised a country as ours. It is that from the very beginning the standard of the courses offered should approach as nearly as possible those of courses leading to a degree. But that conclusion becomes much less manifest when, like, for example, the Royal Technical College of East Africa, whose first buildings are now under erection in Nairobi, the college is being set up in a colonial territory. Excellent reasons can be advanced for providing high-quality education on the spot. It is, for instance, much more difficult than it used to be to get young trained engineers to take jobs abroad when there is so high a demand for their services here at home in Britain. It is a costly business to send to Britain from the Colonies for training students of brighter intelligence, white, Asian or native, whose qualities seem to demand that an opportunity for advancement should be offered them. Nor, it may be argued, can British universities, already overcrowded, be expected to find sufficient places for the numbers the Colonies might wish to send as their educational systems expand. But, in fact, colonial conditions are strikingly different from those here at home. They are so strikingly different that some educationalists find such arguments unconvincing and prove critical of the whole conception of aiming, except in a more distant future, at education of university standard in such Colonies.

In so far as engineering is concerned—we

do not hold ourselves competent to express reliable opinions in other fields—a college setting out to provide courses of university standard must presumably be aiming at the production of fully qualified professional engineers. But the full training of professional engineers demands something more than academic study alone. There must also be practical experience in an engineering works, or amongst civil engineers, in the carrying out of works. There lies the rub. For in many a colonial territory there is little scope for getting that experience. Mechanically and electrically little is manufactured in such a territory, still less designed. The engineering experience to be gained lies predominantly in the operation and maintenance of imported plant. Of its kind this is, indeed, excellent engineering experience. But it is not of the kind that a man aiming to become a professional engineer requires. It is experience better suited to the needs of technicians. Thus, if the college sets out to train professional engineers will it not need to send them to Britain or to Europe or America for practical experience ? Again, it can be justifiably argued that the scope for the work of professional engineers in many colonial territories is very limited, far more limited than is the scope for technicians. In the mechanical and electrical fields there is practically no design and very little construction to be undertaken, and even in the civil field where there is more scope in the building of roads, the extension of railways, the carrying out of drainage, irrigation, water supply and sewage works, and in the fields of health and sanitation, the really major projects and even very many of lesser magnitude are all designed by consultants from abroad and carried out, under the supervision of their engineers, by contractors also from abroad. It can thus be argued with cogency that a technical college in a colonial territory can best serve the interests of the territory if it sets out to train not professional engineers, but technicians, and that it will best serve those amongst its students, of whatever colour or creed, who reveal powers of abstract thought and ability in mathematics if it assists them to leave the college and take a training in a university in some more fully developed land.

But those are arguments that look to the present rather than to the future. It is confidently expected in Uganda and Kenya, for example, that cheap power from the Owen Falls power plant will lead to a period of rapid industrialisation. There are similar expectations in other territories. Ought not preparations to be made now educationally towards meeting demands for professional engineers in the future ? If so, is it not wise to start from the beginning by providing courses similar in character to those of a university ? Again, if university status is to be the aim it is no longer reasonable to think only in terms of engineering courses. In territories that are primarily agricultural and pastural there are still a number of scientific subjects that can be and should be studied on the spot by men educated fully up to university standards. Nor, particularly where the native may bring interesting new qualities of mind to bear, should the arts be neglected. It is interesting to note that science and the arts figure amongst the six departments of tuition initially to be set up at Nairobi. Lastly, can political aspirations be wholly neglected ? It is true that politics is not a comfortable bedfellow for education. But a territory advancing towards Commonwealth status is bound to see in the setting up of a college that aims to become a university yet another step away from political adolescence. Maybe educationalists here at home may feel dubious whether university status ought yet to be the aim of such a college, whether courses of a different character would not better serve a Colony's needs, whether, in existing circumstances, a college will really be able to offer its students all those facilities that are associated with university training. But, after listening to advice, those on the spot must make their own judgment as to what their aim should be. Whether the Royal Technical College at Nairobi, for example, will, in fact, build up for itself a reputation so high as to deserve the conferment of university status is something that only the future can reveal. But if those in Kenya who are working to bring the College into being really believe that a university will soon be needed there, then what other conclusion can they wisely reach than that from the beginning an education as nearly as possible equal to that of university training should be provided by it ?

Literature

Oil in the Middle East : Its Discovery and Development. By STEPHEN H. LONGRIGG. London : The Oxford University Press, Amen House, Warwick Square, E.C.4. Price 25s.

THIS is a book which deserves to be read by anyone, in the Western world, who is at all interested in his future welfare. Without petroleum, modern civilisation could not continue ; without the oil of the Middle East, Western countries would be lost, in every sense of that word. Nobody should be put off by the title. So many books dealing with oil fail to hold the interest of the layman, but in this book there are no dreary pages of production, refining and transportation statistics. Neither are there those endless accounts of routine, and common-place, petroleum company achievements. All the pertinent data are there, however, but are unobtrusive and readable.

Few people, indeed, are more qualified than Brigadier Longrigg to write upon the subject of oil in the Middle East. The author, long accepted as an outstanding authority and writer in the spheres of Arabic culture and history, served in the Middle East during the period when all but one of the present great oil developments originated—and often such origins were a small group of tents pitched in an inhospitable desert. In addition to twenty-five years of Middle East residence as a civil servant and a wartime military officer, Brigadier Longrigg, who has recently retired, was, for twenty years, a senior executive with the oil group having the most extensive operations and interests in Arab countries. Petroleum affairs of all areas from Egypt down to Persia, from Cyprus and Turkey right on through to the Arabian coasts of the Indian Ocean, are fully covered in this book.

More than twenty years ago many oil men appreciated the possible importance of the Middle East. Few of them visualised how very quickly this area would develop, especially during the past eight years, into the greatest producing area outside the United States. The number of active producing fields can still be counted on the fingers of two hands, but the potential oil reserves already assessed amount to 50 per cent of the world total. It is well known, to those with experience, that the oil potentialities of the Middle East have barely started to be uncovered, and this book leads the reader through a logical and interesting discourse of the whole sequence of events, up to the present time. Brigadier Longrigg has produced a work of reference essential even to those engaged in Middle East oil operations.

The author does not hesitate to express his views of the possible results of the sudden impact of great wealth on the few fortunate countries. He gives due credit to the many operating companies which have been directed and served by capable and enlightened men. Everyone must join in the expressed hopes that all the people of the oil-producing countries will enjoy the benefits arising from the efficient and foreign-controlled development of their natural and national resources. To many people, conditioned as they have been by the constant barrage of propaganda from many sources, especially political, some of Brigadier Longrigg's views may not be readily acceptable. It is to be hoped that any disagreement with the perceptive, sincere and experienced opinions to be found in this book will emanate only from those who are able honestly to claim to be of a stature equal to that of the author.

The Locomotives of R. E. L. Maunsell. By O. S. NOCK. Bristol : Edward Everard, Ltd., Broad Street, Bristol, 1. Price 17s. 6d.

THIS is an excellent account of locomotive development on the Southern Railway extending over the period from 1923 to 1937, written by an enthusiastic and painstaking author who appears to have had many friends to aid him in his work. While the main theme of this book is locomotive practice on the Southern Railway, the author also takes in the years 1911 up to 1923, during which Maunsell was on the Great Southern and Western Railway of Ireland at Inchicore and, later, while he presided over the locomotive department of the old South Eastern and Chatham line at Ashford.

The first five chapters of the twelve comprising this work are devoted to the earlier period, and are mainly useful as a means of introducing personalities destined to play a large and important part in locomotive design and construction as practised on the Southern Railway. It was during the Ashford days that such men as G. H. Pearson and Harold Holcroft, both of Swindon, come into the picture, as also does James Clayton, of the Midland, to mention but a few whom Maunsell, as a skilled administrator, gathered round him following his appointment as chief of locomotive matters at Ashford.

The early locomotives designed at Ashford, for which it would seem Pearson and Clayton were largely responsible, included some noteworthy 2–6–0 engines, generally understood to be the first built incorporating advanced valve gear practice featuring long lap valves in conjunction with high-temperature superheated steam.

As time went on, locomotives of this same class having both two and three cylinders became largely in evidence, embracing many components in common. The same general

design was also adopted for 2–6–4 side tank passenger engines, the ill-fated "River" class. It may be recalled that one of these left the road near Sevenoaks, in 1927, with serious consequences, the result being that the whole class was withdrawn from traffic. In connection with this accident numerous trials were carried out with engines of this class having both two and three cylinders; full particulars of these interesting experiments will be found in THE ENGINEER of February 3 and 17, 1928.

Of all the locomotives introduced on the Southern Railway during Maunsell's time, the most notable are without doubt the "King Arthur," "Lord Nelson" and "Schools" classes, built for express passenger services. The author devotes considerable attention to these locomotives in Chapters 6, 8 and 10, which certainly make interesting reading, including, as they do, particulars of their performance as disclosed by official trials; it is thus possible to learn something of the working results of two, three and four-cylinder engines, exemplified by the "King Arthur," "Schools" and "Lord Nelson" classes respectively.

Though of different types in respect of their cylinder and wheel arrangement, they have certain features in common; thus, the diameter of the coupled wheels is the same, while the "Lord Nelson" four-cylinder, 4–6–0 engines and the "Schools" three-cylinder, 4–4–0 class are alike so far as the cylinder sizes, valve sizes and working steam pressures are concerned.

The "King Arthur" class, though admittedly developed during the period under review, is, of course, in reality R. W. Urie's London and South Western design, modified to incorporate certain features initiated at Ashford when the original 2–6–0, two-cylinder engines were built, as previously mentioned. It is important that this should be clearly understood; further, new engines built of the "King Arthur" class generally followed the original. Particulars of the later "King Arthur" class were given in THE ENGINEER of September 25, 1925, from which it will be gathered that they had piston valves 11in diameter, not 10in, as given by the author. The "Lord Nelson" class is the subject of Chapter 8, which will no doubt be found of interest, while, if more detailed particulars of the engines are required, reference may be made to THE ENGINEER of October 15th and November 19th, 1926, where a complete description will be found, supported by numerous drawings.

The "Lord Nelson" class is of interest, mainly on account of the 135 deg. crank setting adopted for the four cranks, involving the provision of four sets of valve gear, a complication considered justifiable on account of the even turning moment obtained, resulting in less liability to "slip" when starting, coupled with some economy in fuel consumption.

Particulars are given of a trial run with a special train from Waterloo to Exeter, when the distance of 83·8 miles from Waterloo to Salisbury occupied (including some checks) 96·25 min, during which time the engine maintained an average of 1292 i.h.p. The coal used had a calorific value of 13,500 B.Th.U. per pound and the consumption was 2·68 lb per indicated horsepower-hour. The cylinder power was, therefore, at the rate of 39·1 i.h.p. per square foot of grate area per hour, and the combined thermal efficiency of the boiler and engines came out at 7 per cent.

Over the same road and running in the same direction an engine of the "King Arthur" class made the run in 93 min, start to stop, equal to a mean speed of 54·0 m.p.h. The average indicated horsepower was 1113 on a coal rate of 2·2 lb per indicated horsepower-hour. The coal on this occasion had a calorific value of 13,690 B.Th.U. per pound. The power developed was 37·1 i.h.p. per square foot of grate area and the thermal efficiency of the boiler and engine combined 8·5 per cent. Turning now to Chapter 10, devoted to the "Schools," the author gives a good account of these engines, the most remarkable of the 4–4–0 type ever built. In respect of the cylinders, valve gear, valves and other related parts, the "Schools" are identical with the "Lord Nelson" class, but have three as against four cylinders. The driving wheel diameters and boiler working pressures are also the same. Keeping these points, common to both, in mind, it is of interest to compare the performance of these two engines as shown by the horsepower curve for the "Lord Nelson," page 102, and that for the "Schools," page 130. The former shows that the four-cylinder engine at 45 m.p.h. and 25 per cent cut-off develops 1350 i.h.p. and at the same speed and rate of cut-off the curve for the "Schools" shows 1120 i.h.p. The powers developed per cylinder are, therefore, 337 and 373·3 respectively.

In connection with the "Schools," the author makes some reference to certain starting difficulties experienced, stating that the lead of ¼in on the valves occasionally gave difficulty through the engine stopping "blind" and unable to move in forward gear. This is thought to be a misnomer. Stopping "blind" infers that all ports are closed to "admission," which would be impossible with the engine in "full gear." Actually, this difficulty brings out a weak point in three-cylinder engines having small cylinders together with a large opening to "lead" and, in consequence, early "pre-admission." The "Schools" have a "full gear" cut-off of 75 per cent, such being the case it is quite possible for the engine having cranks at 120 deg. to each other to stop in such a position that starting with a heavy train might present difficulty. For instance, imagine one crank to be just coming up to, say, the back dead centre. The engine being in forward gear, the valve would be open to pre-admission and the nearest crank at 120 deg. in advance would be at about the point of cut-off, while the remaining crank at 120 deg. in advance of the last-mentioned would be in an unfavourable angular position to exert an effective turning moment, even though the valve would be well open to "admission." This condition, coupled with the small diameter of the pistons, might easily, together with the counter pressure set up by the pre-admission steam already mentioned, prevent the engine from starting.

Further it exposes the objection to large "lead" openings, particularly at starting, which are unavoidable with radial valve gears with a "constant lead." However, with such valve gears, a wide "lead" opening is a necessity, for the reason that at early rates of cut-off "lead" opening forms almost the whole port opening to "admission." In conclusion, a word of appreciation is due for the high quality of the drawings and photographic illustrations, thus adding charm to this record of locomotive engineering on the Southern, which makes the book a worthy counterpart to the paper read before the Institution of Locomotive Engineers by C. S. Cocks in 1948 on the "History of Southern Railway Locomotives to 1938."

As a detailed historical record of the locomotives introduced during Maunsell's time, both from the viewpoint of design and performance in traffic, this book can confidently be recommended.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SIR CHARLES PARSONS

SIR,—Referring to Mr. J. F. Field's letter in your issue June 25th, in fairness to the memory of Sir Charles Parsons, I would like to put on record the work which he did in connection with the development of the re-heating of steam and feed water heating.

Steam re-heating was adopted by Parsons in 1891 in his first condensing steam turbine, and his patent No. 5074 of that year clearly states: "I prefer to steam jacket the engine (turbine) in such a way as to supply the heat as required to maintain the steam in a gaseous condition during its course, and prevent condensation without great excess of temperature above the point of saturation, and several methods of applying the jacketing are shown at Figs. 2, 3, 4 and 5. The jacket may be continuous, or it may be arranged in successive steam jackets or heaters to dry and moderately superheat the steam, on its passage from one set of turbines to the next, and a sufficient surface and number of heaters is provided to prevent condensation." The turbine had an output of 100kW, and after doing experimental work at Heaton Works was installed in the Forth Banks power station of the Newcastle and District Electric Lighting Company. Similar machines were installed in the Cambridge power station but without the steam jackets. Careful tests showed that although there was a saving in steam consumption by the use of the jackets, it was almost nullified by the volume of live steam used in them and the system of steam re-heating was therefore discontinued.

The next attempt at re-heating was by separate firing and was made in the year 1900 on one of a pair of 1250kW turbo-generators supplied to the city of Elberfeld, Germany. This was a two cylinder tandem turbine and re-heating was adopted between the two cylinders. The steam from the high pressure cylinder was passed through a locomotive boiler, in which it was re-heated by a fire in the firebox.

Due to the increasing use of superheated steam no further work on re-heating was undertaken until the year 1916. In that year, however, a 3000kW, two-line machine was constructed for the Blaydon Burn power station, and re-heating of the steam between the cylinders was again adopted. The steam, after leaving the high pressure cylinder, was returned to the boiler-room to be re-heated by waste gases and was then brought back to the low pressure cylinder.

About this time five 11,000kW turbo-generators were being installed in the Carville "B" power station, and it was decided to try out steam re-heating on one of these machines. The turbine was of the two cylinder tandem type and re-heating of the steam was carried out between the cylinders by means of a live steam heater. Careful tests were taken in 1921 by the engineers of the then Newcastle on Tyne Electric Supply Company to determine what actual benefit was derived from resuperheating, and the results obtained were published in the technical press.

In the following year (1922) the order was placed with Parsons for the generating plant for the first section of Barking "A" power station. This comprised the supply of two 20,000kW turbo-generators and two 40,000kW turbo-generators. One of the 40,000kW sets was designed for flue gas re-heating of the steam after partial expansion in its passage through the turbine, the steam being re-heated to the initial inlet temperature. This flue gas re-heat unit remained in operation on re-heat for at least six years, after which it is understood the re-heat boilers were modified to become normal steam raising boilers thus to increase the overall station steaming capacity. Test results showing the

effect of re-heating have been published in the technical press. In the same year (1922) an order was received from the Commonwealth Edison Company of Chicago for a 50,000kW turbo-generator to be installed in the Crawford Avenue power station and again flue gas re-heating of the steam after partial expansion was decided upon, and the actual test results have been published.

The next Parsons machines incorporating flue gas re-heating are three 50,000kW sets ordered in 1930 for the Dunston "B" power station, followed by a fourth ordered in 1937 and two more ordered in 1946.

With regard to feed heating, Parsons' first attempts in this direction was on the 25,000kW turbo-generator ordered in 1912 for the Fisk Street power station, Chicago, U.S.A. In this design a screen of tubes the same size as the condenser tubes was placed horizontally across the whole of the upper opening through which the exhaust steam had to pass before reaching the cooling tubes. The condensate was pumped through these tubes with the object of raising its temperature as nearly as possible to that of the exhaust steam. No steam was extracted from the turbine.

The next stage in the development of feed heating was made in 1916 on the 3000kW turbo-generator at Blaydon Burn power station, already referred to in connection with re-heating. Two stage feed heating was employed by means of steam tapped off the turbine, the condensate being raised to a temperature of 234 deg. Fah.

Feed water heating was also adopted on the Carville "B" turbo-generators, in 1916, single stage heaters being employed to raise the feed temperature to 140 deg. Fah. Similar arrangements were used in the following year on the 15,000kW turbo-generators at Dunston "A" power station.

All the above information was given in the series of articles entitled "The Development of the Parsons Steam Turbine," which were published in THE ENGINEER in 1934.

Sir Charles Parsons was fully aware of the work done by Weir, Normand and Ferranti on feed water heating and did in fact make reference to this in his paper on "Steam Turbines," read before the first World Power Conference in 1924.

C. D. GIBB

Newcastle upon Tyne, July 1st.

COASTAL FLOODING

SIR,—The answers given by the Departmental Committee on Coastal Flooding to the questions of the Home Secretary on the Floods of February, 1953, are peculiar and puzzling.

The terms of reference to the committee, when paraphrased, were :—

(*i*) What caused the floods of February, 1953, and will they occur again ?

(*ii*) How strong should the sea defences be, remembering they must be cheap ?

(*iii*) Is it possible to warn people about floods beforehand ?

(*iv*) Who is to decide what defence is necessary and who is to pay ?

The Home Secretary asked for an interim report on item (*iii*)—Warnings, which was duly given. It is, however, simpler to consider the four terms of reference in order.

In reference to Item (*i*) "What caused the floods ?" the committee said, of course, that they were due to a storm of record severity and pointed out that floods could be much worse than this one, if such a storm were to coincide with the peak of a Spring tide or a heavy fluvial flood (in an estuary) or both.

On the matter of recurrence they give a table showing a quite startling increase in the frequency of very high sea levels. The records extend from 1820 to 1953 with a twenty-year gap from 1858 to 1877. From 1820 to 1896 the sea level at Sheerness never exceeded 13ft above datum ; in the thirty-nine years 1896 to 1934 this level was exceeded twice, but in the twenty years from 1934 to 1953 it was exceeded four times—once every five years. The report also points out that the land level of England is falling and (independently) the sea level is rising.

Despite the foregoing facts the committee, in reporting on Item (*ii*) (the strength of future defences) appear to be obsessed by the order to keep everything cheap. The statistical frequency of a flood of the magnitude of 1953 is at present only 1 in 200 and, they say, there is therefore no need to protect against anything worse. It should be noted that after the disastrous 1928 flood a committee said there was no need to protect against anything worse than that one, but the 1953 committee hedges against its own criterion by saying that in some areas the defences need not be so strong as to meet a 1953 flood and in others they can (? should) be stronger. They also propose that the people who are to decide on the strength of the defences should be the authorities responsible for each area concerned. Then comes this lovely sentence :—

"In saying this we do not, of course, intend to fetter the discretion of the Departments when deciding whether any particular scheme should qualify for a grant."

Translated from "Gobbledygook" into English, this means that the Treasury will decide.

Coming now to the question of warnings, the committee point out that the height of surges cannot be foretold, but they have devised a system of "Crying Wolf" from September 15th to April 30th every winter. The report defines the persons who are to decide when a warning is to be given and to whom it is to be given. They further make the admirable suggestion that authorities who are likely to receive warnings should have decided beforehand what to do when they get them. Mention is made of the fact that 300 people lost their lives in the floods last year but no specific suggestion is made as to how this should be prevented. The committee say, however, that if a system of warnings had been in force in February, 1953, probably most of the people who were drowned could have run away in time to save their lives.

To give a warning whenever north-easterly storms are raging in the North Sea during the winter at Spring tides means that there will be a warning about every other Spring tide and very soon people will take no notice of them.

There is no room to discuss Item (*iv*) (the administration and finance of proposed defence measures), but a few lines about the protection of the Thames Estuary may be of interest, as the committee devote some space to this subject. They seem to have a curious allergy to the word "barrage." They discussed "a barrier across the estuary, leaving gaps through which shipping would be allowed to pass." Further, they discussed a proposal "to interpose a suitable structure across the river which would be provided with gaps, &c., &c.", and finally that investigation should be undertaken urgently into the possibility of providing "a suitable structure, capable of being closed, as a means of reducing the maximum water levels higher up the river at the time of a surge."

It is, of course, well known that the Port of London Authority, during all the inter-war years, were bitter opponents of a barrage being built in the Thames, and now that the committee decide that such a project should be investigated "urgently" they still cannot bring themselves to use the word "barrage." The position as regards such structures is that the Thames Barrage Association, which was formed last century, had, after many years of investigation, brought sufficient pressure to bear on the Government in 1938 for them to order a Departmental Inquiry into the Association's project for a barrage at Woolwich at the upstream end of Galleon's Reach, where there is 30ft of water at low tide. The inquiry was to be held on March 28, 1938, but the Germans took Vienna on March 15, 1938. Thereupon the Committee of Imperial Defence intervened to say that no additional hazard must be built in London and the inquiry was cancelled. The project was revised after the War, when a new London was being planned, but Lord (then Mr.) Silkin turned it down flat, without investigation or reason given.

Now that the Coastal Flooding Committee has said that the investigation of a Thames Barrage is an urgent matter the site at Woolwich cannot fail to be studied by any engineer who has to make the investigation proposed by the committee. This site has many advantages over any other and has been given wide publicity and been fully described in books and articles. It is surprising that the project is not mentioned in the present committee's report, possibly because they thought a barrage by any other name would not be so objectionable to the P.L.A.

The committee's report concludes with twenty-six recommendations, of which two deal with research, two with statistics, six with engineering, fifteen with finance and administration, and there is one (No. 11) which is a jumble of instructions about the standard of protection.

The committee's report has instituted a system of warnings which will take effect several times every winter, although the height of a surge cannot be forecast. It has set a standard for defence, but said that some areas will have less and some will have more than this standard, and has made no proposal for saving life except that when one of the foregoing warnings is received people in the danger areas should run away. Nevertheless, if the Liverpool Tidal Institute gets a bit more money for research, as is proposed, and there is an independent technical investigation into a Thames barrage project, the report may be considered to have done some good. An unknown sum was spent on inadequate defences after 1928 ; over £15,000,000 was spent in 1953 ; the damage done in 1953 was £30,000,000 ; 300 lives were lost in 1953.

How much should be spent to prevent damage by a recurrence of a 1953 flood or worse ?

F. NEWHOUSE

Twickenham, Middlesex, June 30th.

FRENCH LOCOMOTIVE EXPERIENCES

SIR,—I have read Mr. Livesay's "French Locomotive Experiences" with great interest and enjoyment, and would like to congratulate him on the admirable way in which he has combined the technical with the operational and social ; it could not have been better done ; I really believe nobody else could do it ; certainly I have never come across anything like Mr. Livesay's articles, and I have read them from his first contribution which appeared before the war.

On two previous occasions I have written to say how much I have appreciated his articles, because they not only contain a mass of information gathered at first hand, but are put together in such a way that a non-railway engineer, such as myself, can enjoy reading them. The little homely touches, the humour, the "humanities," as he has always emphasised, are just the things that make them so pleasing. Reading his French articles brings before one a vivid picture, not only of the engines themselves, but of life as it is lived on the S.N.C.F. As I said once before, they are alive ; one can imagine oneself in France and in the cab, too. Personally, I think they are inimitable.

One gathers that Mr. Livesay is not as young as he once was, but I can only say that he must be gifted with perpetual youth ! Only a man loving locomotives and young in heart and spirit could have written those articles, to say nothing of undertaking such an obviously strenuous assignment, and making a success of it.

London, N.W., June 24th. JAMES STOKES

Royal Show at Windsor

No. II—(*Continued from page* 17, *July* 2*nd*)

THE Royal Agricultural Society's annual show opened in Windsor Great Park on Tuesday last, July 6th, and will end this evening. Apart from breaks caused by the two world wars and on one occasion by an outbreak of foot-and-mouth disease, the show has been held annually since 1839. The last occasion on which it was staged in Windsor Great Park was in July, 1939, when the Royal Agricultural Society celebrated its centenary. This year, Her Majesty The Queen has graciously consented to accept presidency of the Society and on two days this week has honoured the show by her presence.

The programme for each day of the show has included many interesting as well as spectacular events. One such event has been a parade of ancient and historic carriages. About sixty of these vehicles, including horse buses, a mail coach, a hansom cab, and barouches and landaus from the Royal Mews, may be seen in a static exhibition which has attracted many visitors to the show. The trade exhibits are shown on 685 stands (compared with 623 stands at last year's show at Blackpool), which take up a space of approximately 1,250,000 square feet. The majority of these stands are occupied by the manufacturers and dealers of tractors and agricultural machinery and implements. These exhibits constitute an increasingly important part of the Royal Show, demonstrating as they do the continuing progress of the agricultural engineering industry. In our last issue we began a description of some of the machines and implements to be seen at the show. That description is continued here.

For many years Bamfords, Ltd., Uttoxeter, Staffs, has exhibited grass cutting and hay handling machinery at the Royal Show, in addition to small oil engines and hammer mills. The firm is again showing a selection of these products and also includes on its stand the latest version of the Bamford-Long automatic pick-up baler (Fig. 7) for hay and straw. The baler is claimed to have a capacity of 10 tons or so an hour and can handle six to eight 60-lb bales a minute. The baler is tractor drawn and is powered by an Enfield twin-cylinder diesel engine, petrol and vaporising oil engines being also available, if desired. The machine is simply constructed, the drive being taken through gearing direct to the crankshaft and from there to the feed reel and auger, pick-up and knotter.

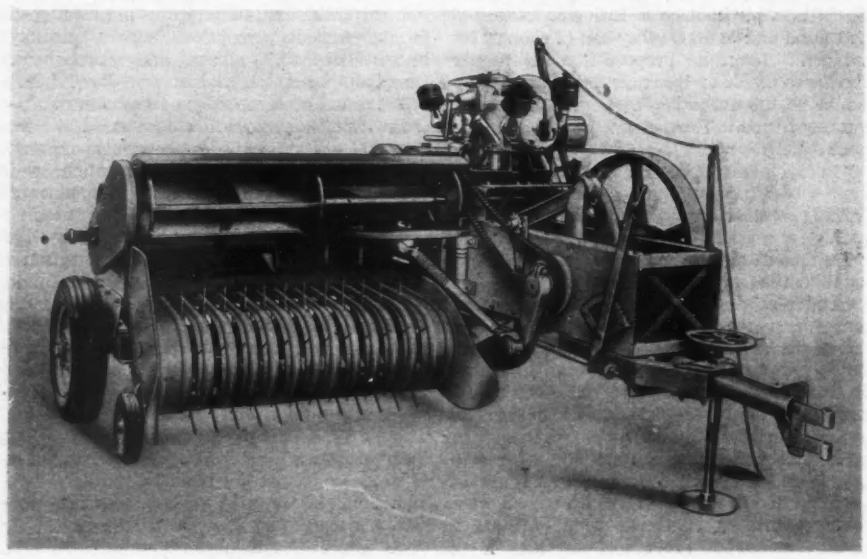


Fig. 7—Bamford-Long automatic pick-up baler. The pick-up drum is 5ft wide, and the minimum capacity of the baler is 10 tons an hour

The twine fingers which effect the knotting swing backward during the tying operation and provide enough slack to form the knot. An automatic bale tension bar is fitted at the top of the baling chamber ; it is angled downward in front of the chamber, which means that the maximum tension is exerted on the front bale in the chamber, i.e. the one being formed and tied. Three dogs in the top and bottom of the chamber hold the crop tightly while the plunger returns to the front of the baler for a new charge. The pick-up drum, which is 5ft wide, is spring counterbalanced so that it can adjust itself quickly to any inequalities in the ground on which the baler is working. The safety devices which have been incorporated in this machine include shear pegs on the fly-wheel and sweep fork arm, overload clutches on the pick-up and auger drives, and a safety lock on the plunger to guard against broken needles. The baler housing is fitted with renewable steel wearing plates on the bottom and side of the baling chamber and adjustable wooden runners are provided on the plunger. The baler is operated by rope control from the tractor seat, and the drawbar can be adjusted to left or right to swing the machine into line with the tractor when travelling through gateways or in narrow lanes.

Among the exhibits of David Brown Tractors, Ltd., Meltham, Yorks, there are examples of the diesel and vaporising oil-engined wheeled and crawler tractors which it manufactures. Since the last Royal Show this firm has introduced a light diesel-engined tractor of 31·5 b.h.p., and there is also now a modified version of the "25" four-cylinder vaporising oil-engined tractor, which has been specially converted for work in orchards and hopfields. The firm's heavier crawler tractors have been modified by a change in the engine frame and track suspension. The original suspension comprised a rigid beam mounted on two coil springs. This has now been replaced by a single transverse leaf spring, an alteration which, it is claimed, reduces strain on the tracks and engine frame. Another modification, which has been made to the six-cylinder diesel track tractor (50TD) only is the introduction of an additional lower track roller, making five in all.

One of the new implements shown by David Brown Tractors, Ltd., is the mounted one-way plough, illustrated in Fig. 8. The plough, which weighs 5 cwt, has finger-tip control, the change-over being semi-automatic, in that the idle body is raised clear as the plough is lowered into work. The equipment of the plough includes 16in deep digger bodies, and the ploughing depth and width are controlled respectively by a large hand-wheel and eccentric cross shaft hitch. There are linkage screws for controlling the pitch and level of the plough, and the pitch of the plough bodies can be adjusted independently. Another new implement on the David Brown stand is illustrated in Fig. 9. It is a spring tine cultivator, which is suitable for use in the general preparation of seed beds as well as for the inter-row cultivation of root crops and such crops as maize and

Fig. 8—David Brown one-way plough attached to "24D" diesel tractor

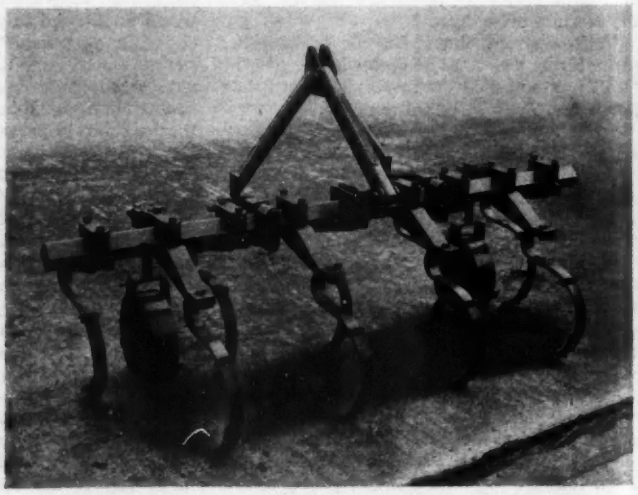


Fig. 9—David Brown spring tine cultivator. The tool frame width is 6ft 6in

cotton. This implement consists of a single main frame of 2in square tubing, to which are clamped nine S-shaped flat spring tines having reversible points. The depth of work is controlled by two 12in. diameter cast iron wheels fitted with conical bearings which can be adjusted to take up wear. The wheel assemblies are also adjustable. The width of the main frame carrying the tines is 6ft 6in, and it gives a ground clearance of 18½in.

The principle of rotary cultivation, or "rotavation," as it is often called, is exemplified by the exhibits of Rotary Hoes, Ltd., East Horndon, Essex. The "Rotavator" system, introduced in this country in the 1930s by Mr. A. C. Howard, is based on the rotary movement in the ground of L-shaped hoe blades. The "Rotavators" shown at Windsor range from small hand-controlled petrol-engined models for garden and nursery work to tractor-operated machines having a working width of 6ft and capable of cutting to a maximum depth of 8in. The latest additions to the series of "Rotavator" models are the "Yeoman" and the "Bulldog." An illustration of the former is given in Fig. 10. It is a medium-size hand-controlled cultivator powered by a Villiers Mk. 40, four-stroke, single-cylinder petrol engine which develops 4·2 b.h.p. at 2150 r.p.m. The drive from the engine is taken through a spur reduction gear to worm and wheel final drive, all the gears being solid-cut and case-hardened and mounted on alloy steel shafts. There is a single dry plate, hand-operated engine clutch and the two-ratio gearbox gives the following speeds :—High ratio travel speeds of 1·05 and 2·38 m.p.h., and a reverse speed of 1·37 m.p.h., with the hoe rotor turning at 220 r.p.m.; low ratio speeds of 0·73 and 1·65 m.p.h., and a reverse of 0·94 m.p.h., the rotor speed being 150 r.p.m. A power take-off stub is fitted behind the transmission housing. It is slightly offset to the right and carries its own hand-operated sliding dog. A three-position lock puts both the wheels of the machine in or out of gear, or applies drive to one wheel only to facilitate turning. The transmission controls, as may be noted in our illustration, are conveniently grouped round two central quadrants, and the handlebars are adjustable for height and can be swung laterally to either side. The rotor, which carries eight blades, has a bevel gear primary drive, the final drive being by ¾in pitch roller chain through a multi-plate friction safety clutch. The working width of the "Yeoman" is 15in and the depth of cultivation may be adjusted to a maximum of 9in in most soils. The rotor can be easily removed to permit the attachment of the various accessories which can be operated by the machine. These accessories include a cutter bar, front and rear tool bars, belt pulley, and vee belt power take-off unit. These attachments are mounted and unmounted by a "Snaplok" lever-operated clamp. The rotor or any of the accessories can be removed by the single operation of the lever. The attachment is registered by a large diameter spigot and dowel pins on a flat surface, which gives complete location and rigidity, the overcentre linkage being fitted with a simple screw adjuster to facilitate taking up the wear over the clamping faces.

Fig. 10—Hand-controlled "Rotavator" for small holdings. The depth of cultivation is adjustable to 9in maximum

The "Bulldog" is a small machine, suitable for garden work, which is powered by a J.A.P. four-stroke, single-cylinder petrol engine developing 1·25 b.h.p. at 2500 r.p.m. Power is transmitted by a vee-belt drive to a worm shaft and gear driving the road wheels, and a worm gear drive takes the power to the rotor. The handlebars are adjustable for height and the three controls are the clutch by which the vee belt can be tensioned, a three-position wheel lock, and an adjustable depth control skid. The rotor of the "Bulldog" is 10in wide and normally carries four blades, but the width of the rotor can be increased by adding extra blades. As the rotor has a centre drive a coulter is provided to eliminate the centre dead spot. The working depth of the machine is 4in at the first cut on normally cultivated land, although deeper cultivation is possible if the soil conditions are favourable.

The "Platypus" crawler tractors, which Rotary Hoes, Ltd., manufactures at its new factory at Basildon, Essex, are also exhibited. The latest of these tractors, the "Platypus 50," is illustrated in Fig. 11. The engine installed in this tractor is a Perkins "L.4" four-cylinder diesel, 4in bore and 4¼in stroke, which develops 51 b.h.p. at 1600 r.p.m. A two-ratio gearbox provides for three forward and two reverse speeds in each ratio, and steering is effected by an epicyclic gear controlled differential which gives positive drive on both tracks at all times. The 14in dry single-plate clutch is actuated by a hand-operated overcentre control lever, and the final drive is by gear wheel and pinion. The track assemblies of the "Platypus 50" are pivoted forward of the track sprockets to give positive alignment of the tracks and independent oscillation over uneven ground. The gauge of the tracks is 52in, and there are alternative track widths of 16in or 24in. The maximum drawbar pull of the new tractor is stated to be 12,000 lb. Its additional equipment includes a rear power take-off shaft working at two speeds of 750 and 590 r.p.m.

Another "Platypus" tractor shown at Windsor is the "30," which is a wide gauge crawler with 46in track centres and 12in track plates. This tractor also is powered by a Perkins "P4" diesel engine. The illustration, Fig. 12, shows the "Platypus 30" fitted with an angledozer, which is available with blade widths of 6ft and 7ft. The height of the blade is 22in, the maximum lift above ground being 32in and the maximum drop below ground 10in. The weight of the tractor and angledozer together is 2 tons 17 cwt.

A section of the Royal Show which is of particular interest is that concerned with forestry. Here, the Timber Development Association has arranged an exhibit which demonstrates the many uses of timber in present-day agriculture. It includes a Dutch barn, with three bays of 30ft span, 45ft long and 16ft to the eaves, which has been built in accordance with the "rigid frame" system of construction, steel plates and timber connectors being used at the joints. The Association is also showing a plywood grain silo, 12ft high and 10ft 3in in diameter, which has a capacity of about 20 tons of grain. In addition, there are many examples of wood fencing, gates, some 15ft lamp standards, and a collection of tool handles as used by carpenters and foresters. A final important item in the exhibit is a forklift truck operating with two-way and four-way entry wooden pallets of various designs.

On some of the machinery stands equipment for handling and dealing with timber is exhibited. An exhibitor of some of this equipment is Stenners of Tiverton, Ltd., Lowman Works, Tiverton, on whose stand there is shown the combined bandsaw push bench with rolling and fixed tables, illustrated in Fig. 13. This machine is virtually two machines in one; as a band push bench with rolling tables it will deal with the breaking down of medium-size round logs, and the fixed table, which can be swung quickly

Fig. 11—"Platypus 50" crawler tractor fitted with Perkins diesel engine developing 51 b.h.p.

Fig. 12—"Platypus 30" wide-gauge crawler tractor fitted with angledozer

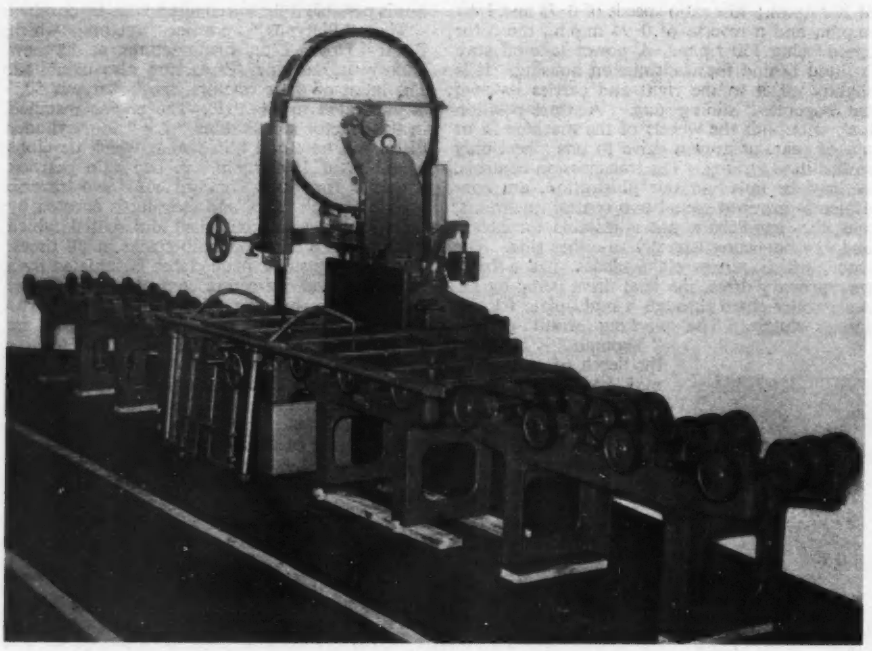


Fig. 13—Stenner combined bandsaw and push bench

into position, converts it into a hand-feed re-sawing unit. The bandsaw frame, which is in one piece, is supported on a substantial bedplate, and the upper pulley slide is adjustable for quick changing of saws and for saws of various lengths up to 23ft ; the knife-edge saw-straining gear and upper pulley bearing housings are carried on this slide. Both the top and bottom saw pulleys, which are 42in diameter and 4½in wide for a 5in saw width, are mounted on heavy spindles carried by roller bearings. Scrapers, brushes and oil pads are fitted to the pulleys and the saw for cleaning while running. There is a conveniently placed control for tracking the saw, and the upper saw guide is adjustable by a handwheel and is counterbalanced.

The rolling tables, which are built of steel plate, are provided with steel guide rails to locate them on the rollers. On the top of the tables cross bars are fitted to assist the manipulation of timber, and detachable curved dogging hooks are provided for the front table to hold round timber. Rolling tables of 10ft, 12ft, 15ft or 20ft in length are available, the width in each case being 1ft 8in and the table height 2ft 9in. The fixed table (Fig. 14), the dimensions of which are 3ft 9in by 2ft 4½in, is arranged on hinges at the left-hand side of the centre frame of the machine ; it can be turned over completely when not required and hangs down in front of the centre frame. There is a loose plate in the fixed table to enable the saw to be changed quickly, and on the bottom saw pulley spindle a brake is fitted to reduce the time required to stop the machine when changing a saw. The front end of the machine's centre frame has been arranged to allow the operator an easy stance for hand feeding when the fixed table is being used, the roller stand adjacent to the machine at the feed end being mounted on a slide base so that it can be set back to give an operating space of 24in. Locating strips and a locking device are provided to enable the correct positioning of the stand after moving. Another detail of the equipment is the quick-acting canting fence fitted with a dial gauge which shows the distance (maximum 18in) from the saw to the fence. The main drive for this sawbench equipment can be by electric motor and vee belts, fast and loose pulleys, or mitre gearbox, as required. With a 25 h.p. motor the saw operates at a speed of 650 r.p.m.

In Fig. 15 we illustrate one of the accepted entries for the Royal Agricultural Society's silver medal. It is a simply constructed tractor-operated ditch cleaner, which has been constructed by Barford (Agricultural), Ltd., Belton, near Grantham. The implement consists of a welded steel lattice girder boom, which is attached by an anchor frame to the power lift of a tractor. The boom is 9ft 6in long and its width at the bucket end is 3ft. The bucket is 3ft wide, 11in deep and 1ft 3in long and its tipping action is controlled by a steel cable operated by a le er which is within easy reach of the tractor driver. Skids have been fitted to the underside of the frame to assist the smooth action and the easy movement of the cleaner up the side of the ditch. Another new machine shown by Barford (Agricultural), Ltd., is a power scythe, which is operated by a Villiers 1·9 h.p. four-stroke petrol engine. The machine, which is fitted with pneumatic-tyred wheels, is handle-bar controlled and carries a cutter bar attachment 36in wide. There are other attachments, including a 20in lawn mower, a liquid sprayer, a hedge trimmer, and a blade mounting for snow or spoil clearance, for operation by this machine.

Fig. 15—Barford ditch cleaner operated by a tractor power lift

(To be continued)

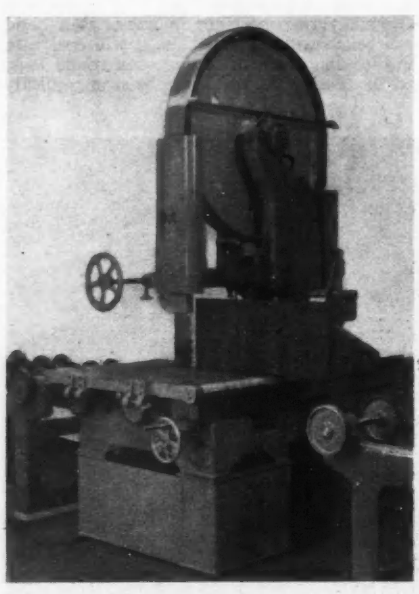


Fig. 14—Bandsaw push bench showing fixed table in working position

Portishead "B" Power Station

ONE of the technical visits that was arranged for the summer meeting of the Institution of Electrical Engineers in the Western Centre last week was to Portishead "B" power station. This station, which is in the South Western Division of the British Electricity Authority, is sited on the Severn Estuary between the Portishead dock and the existing Portishead "A" power station, as can be seen from the accompanying plan diagram.

The new power station is designed to have an ultimate capacity of 360MW, comprising twelve 300 k.lb/hr. boilers and six 60MW turbo-alternators with steam conditions of 900 lb per square inch and 900 deg. Fah. at the turbine stop valve.

Construction of the first two-thirds of the station was authorised some time ago and site works are now well advanced ; the first set is due for commissioning towards the end of 1955, Nos. 2 and 3 sets in 1956, and No. 4 set in 1957. Authorisation has recently been received to install Nos. 5 and 6 sets and associated boilers in 1959 and 1960, but so far no orders have been placed for this last section of the station.

The plant is designed to burn South Wales coal, which will be seaborne to Portishead dock. Telpher unloaders will unload the coal on to the belt conveyor system, which will deliver the coal to the bunkers, to the working coal store, or into wagons for handling to the reserve store. The maximum rate of feed to the bunkers will be 400 tons per hour on a single 42in belt.

The boilers are p.f. fired and are being supplied by Mitchell Engineering, Ltd.; they will have International Combustion, Ltd.'s p.f. equipment and corner-fired furnaces. The boiler plant includes all-welded economisers, regenerative air heaters and both mechanical dust arrestors and electrostatic precipitators. The flue gases will be discharged through two 380ft high brick chimneys, which will be separated from the main building by a roadway, as indicated in the diagram. Each boiler will be fitted with automatic oil ignition equipment, which can also be used for pressure raising. Each pair of boilers will be operated from a combined panel and will be fitted with fully automatic control equipment.

Wet ash hoppers are to be installed under each boiler and from this the ash will be sluiced to a central swirl pit, thence pumped to settling pits to the south of the coal store. The water will be drained off at the settling pits and pumped back for re-use in the sluice system. Dust from the

grit collectors and the precipitators will also be sluiced to the common swirl pit and then pumped with the ash. The drained ash and dust from the settling pits will be lorried to the nearby ash disposal grounds.

An interesting part of Portishead " B " power station is the circulating water system. Four inverted horseshoe-shaped culverts, each equivalent to 9ft in diameter, are being driven out to a dredged channel in the Severn Estuary. These culverts will connect to three 45ft diameter pump pits, each one being associated with two turbo-alternators. The tunnels, which are concrete lined, are each about one-third of a mile in length. Because of the extremely high tide range at Portishead (over 51ft between highest and lowest recorded tides) the tunnel inverts are at −37·5ft O.D. level. Each tunnel is intersected by a 21ft diameter 70ft deep pit, which will contain two 72in wide vertical band screens fitted with variable-speed drives.

The valve and pipework arrangement in each pit will permit the selection of any culvert for inlet or discharge. To reduce the amount of electrical gear in the humid conditions prevailing in the pits and to ensure rapid operation, the valves will be worked hydraulically. During certain seasons the vertical band screens in the " A " station have been jammed by weed blankets, and to clear these the culvert flow must be reversed. This flow reversal will be more rapidly achieved with the hydraulically-operated valves in the " B " station.

Each pump pit will contain four centrifugal circulating water pumps, each of 25,100 gallons per minute capacity, two pumps being associated with each set. The pump motors will be mounted at turbine house basement level (30·0ft O.D). approximately 75ft above the pumps, necessitating long vertical driving shafts.

Each turbine has a single horizontal condenser with a net cooling surface of 58,600 square feet. The condensers are split vertically and either half can be opened up for on-load cleaning. Because of the serious trouble with graphitic corrosion that has been experienced in the estuarine stations in the South Western Division, a special protective treatment is being given to the cast iron pipes, manifolds, condenser and cooler water boxes. The condenser water boxes are to be electrically insulated from the tube plates and are being protected with a synthetic coating.

To take full advantage of siphonic action the condensers are located in pits at −11·0 O.D. level. The turbines stand at 58·0 O.D. level and the exhausts are connected to the condensers by long steel trunkings. The total volume to be exhausted when raising vacuum is 17,770 cubic feet, and in spite of this requirement the equipment is designed for raising vacuum and running up to full speed in forty-one minutes, using a steam exhauster and two three-stage steam ejectors. Although the h.p. turbine glands are to be steam sealed the l.p. glands are to be water sealed at all speeds.

The alternators, which are to be hydrogen cooled, will generate at 11·8kV. The voltage is to be stepped up to 132kV in the 72MVA outdoor generator transformers installed just outside the turbine house wall. Three-core gas-filled pressure cables will connect these transformers to the h.v. air-blast switchgear in the new switching station which is being constructed on the old ash disposal grounds at the opposite side of the Portishead dock. To take the generator and pilot cables to the switching station two cast iron lined tunnels have been constructed under the dock entrance lock. Each tunnel has vertical shafts, 12ft in diameter and 83ft deep, and horizontal tunnels, 8ft in diameter and 345ft long. The overhead 132kV conductors from the " A " switching station are being replaced by cables through these tunnels as the overhead lines would have been fouled by the new " B " station buildings.

All the switchgear in the station itself and the h.v. switchgear in the new switching station is air-break equipment. The " B " station will take auxiliary supplies from the " A " station through three 33kV cables connected to 7·5MVA, 33/3·3kV station transformers. These connections are for use in initial commissioning and for common station auxiliary supplies. Normally the boiler and turbo-alternator auxiliaries will be fed from the 6MVA unit transformers associated with each set. The station and unit transformers feed the 3·3kV, 150MVA rupturing capacity unit and station distribution boards and through these to auxiliary transformers to the 415V distribution gear. All motors above 100 h.p. will be fed at 3·3kV, the variable-speed drives on the boiler auxiliaries being provided by a.c. commutator motors with induction regulators.

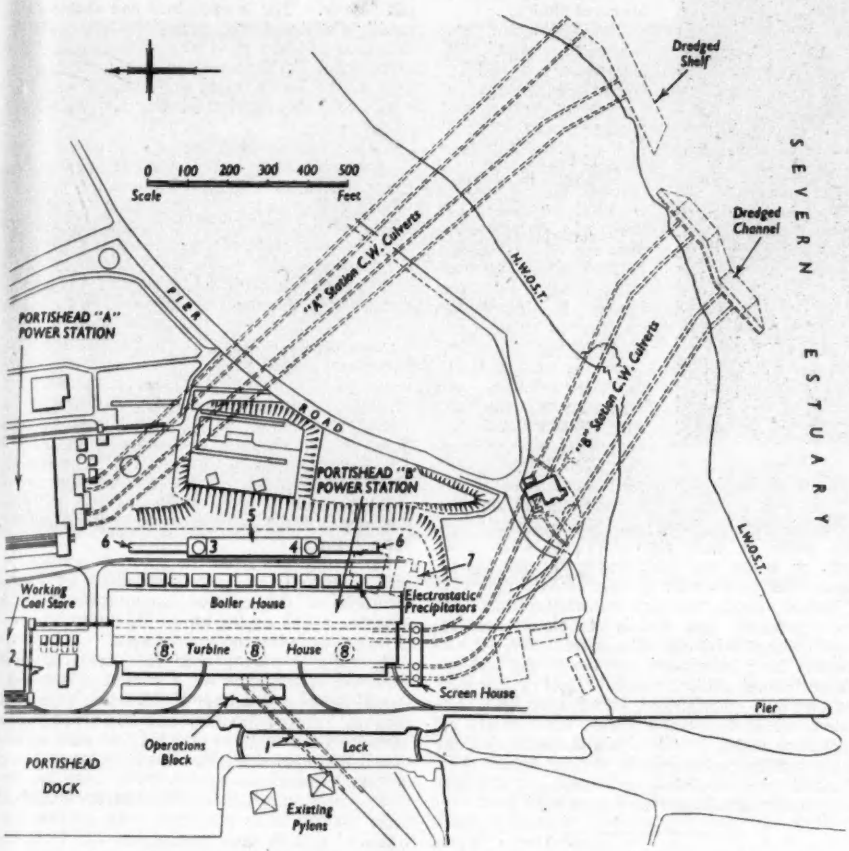
The turbo-alternators will be the new Metropolitan-Vickers two-cylinder short-frame sets with an overall length of 72ft 2in. The machines will be disposed in line, the steam ends of each pair of sets being adjacent.

To meet the particularly low value of resistance to ground required by the G.P.O. the cast iron linings of the three pump pits and two cable tunnels are being used for station earthing.

The station control room, which also houses the controls for the 132kV gear, is situated in the operations block on the station centre line. There is to be a welfare block next to the operations block containing canteen, locker rooms, ablutions, &c. Workshops and stores are being built underneath the flue supporting structure at the back of the boiler house.

Because of the inclined formation of the underlying rock and the fact that considerable excavation would have been necessary for the pump and condenser pits, it was decided to excavate generally to rock over the whole site and to use mass concrete for the foundations. Welding is being used extensively in the steelwork fabrication and the columns are all-welded box sections. The walls are to be of orthodox brick-panelled construction, sand lime and buff facing bricks being used for inner surfaces to give maximum lightness. The roofs are being made of precast concrete slabs and the floors of in-situ concrete. The coal store transporter tracks are piled. Pressure piling is used on the eastern side of the store, to avoid damage to the dock wall ; 30ft precast piles are used on the western side.

The whole of the power station works are being engineered by the generation construction department of the South Western Division, with Sir William Halcrow and Partners as civil engineering consultants. The switching station and the overhead cable diversion is being engineered by the transmission construction department of the South Western Division.



1—Cable tunnels. 2—Coal conveyors. 3—No. 1 chimney. 4—No. 2 chimney. 5—Ash pump house, bulk oil store and machine shop 6—Workshop and stores (flues over). 7—Baily's mill. 8—C.W. pump pits

Diagrammatic plan of Portishead " B " power station

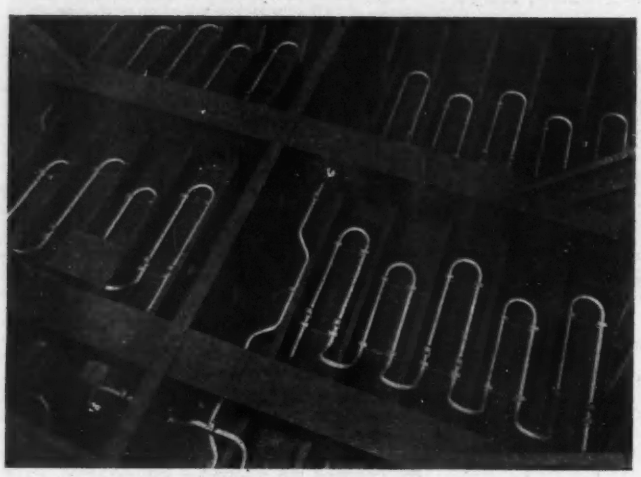
Main Contractors

The main contractors for the works now proceeding are as follows :—Foundations, tunnels and foreshore works, Charles Brand and Son, Ltd.; structural steelwork, Sir William Arrol and Co., Ltd.; superstructure and ancillary works, John Laing and Son, Ltd.; boilers, Mitchell Engineering, Ltd.; turbo-alternators and condensing plant, Metropolitan-Vickers Electrical Company, Ltd.; h.p. and l.p. pipework, Stewarts and Lloyds, Ltd.; 132kV air-blast switchgear, Metropolitan-Vickers Electrical Company, Ltd.; 3·3kV and 415V switchgear, English Electric Company, Ltd.; contactor starters, Brookhirst Switchgear, Ltd.; main and auxiliary cables, W. T. Glover and Co., Ltd., and British Insulated Callender's Cables, Ltd.; transformers, Metropolitan-Vickers Electrical Company, Ltd., Bryce Electric Construction Company, Ltd., and Yorkshire Electric Transformer Company, Ltd.; motors, Metropolitan-Vickers Electrical Company, Ltd., Laurence Scott and Electromotors, Ltd., and Mather and Platt, Ltd.; boiler feed pumps, Sulzer Bros. (London), Ltd.; coal-handling plant, Strachan and Henshaw, Ltd., and Spencer (Melksham), Ltd.; ash and dust-handling plant, B.V.C. Industrial Constructions, Ltd.; central evaporators, Aiton and Co., Ltd.

Atomic Energy.—More than 700 scientists, working on the peaceful uses of atomic energy in thirty different countries, are to meet at Oxford from July 19th to 22nd to discuss advances made in the last three years. These scientists will attend a conference, organised by the Atomic Energy Research Establishment, Harwell, on isotope techniques. Developments in medical research and treatment, in industrial processes and in agricultural research will be discussed. A notice from the Department of Atomic Energy announcing the conference points out that the uses of radio-active isotopes are increasing rapidly, and Britain has become the leading exporter to Europe, the Commonwealth and other countries outside the United States. Most of the materials come from Harwell, but at the Radiochemical Centre, Amersham, the work of a team of chemists specialising in the production of chemical compounds incorporating isotopes has been arousing world-wide interest. Orders at these two centres are now being dealt with at the rate of 15,000 a year, of which over 5000 are to other countries. In the past six years radio-active isotopes have been sent to forty-two different countries from the United Kingdom.

Aluminium Alloy Oil Tanker Heating Coils

THE problem of corrosion in the cargo oil compartments of oil tankers has been engaging the attention of ship owners for many years, and several methods have been evolved for the protection of the ship's structure in order to reduce the high cost of maintenance and renewals. Apart from the actual steel structure of the tanks, fittings are also subject to corrosion attack, and this applies to the cargo heating coils. These are fitted in tankers carrying crude oil, and the heavier hydro-carbon fluids, in order to raise the temperature of the cargo and reduce its viscosity so that pumping operations may be facilitated. Steam is the usual heating medium and the coils are laid in the spaces between the longitudinal bottom frames and arranged to give an even distribution of heat.



Arrangement of aluminium alloy heating coils in cargo oil compartment

It is general practice to use 2in nominal bore mild steel pipe for the heating coils as being suitable when due regard is paid to the heat emission of the surface, made available by the piping arrangements, in relation to the steam-carrying capacity of the pipe. However, the wide variety of oil carried as cargo, alternating with periods when the tank is filled with water ballast or used as a non-ballast compartment, are conditions which set up serious corrosion of the heating coils. In recent years the greater resistance to corrosion possessed by cast iron has been utilised and cast iron pipes, both plain and finned, have been used in the heating coil systems. However, the material has the disadvantages of greater weight and greater liability to fracture.

Under these conditions the possibilities of employing a non-ferrous metal is attractive provided that the material chosen is resistant to corrosion by chemical action and by electrolytic action. This question was studied by Steels Engineering Installations, Ltd., Crown Works, Sunderland, and the company has developed a system of aluminium alloy heating coils which, it is claimed, upon the results of extensive laboratory tests and accelerated full-scale service tests, is equal to the mild steel pipe system in heating efficiency, is free from corrosion and represents a considerable saving in weight. Our photograph shows an aluminium alloy heating coil system installed in an oil tanker. The special aluminium alloy, selected for the purpose, is highly resistant to corrosion under the conditions obtaining in the cargo oil tanks, and has an ultimate tensile strength of 12 tons per square inch, a 0·1 per cent proof stress of 7 tons per square inch and an elongation of 18 per cent on 2in. Another advantage of the aluminium alloy is that, due to its low value of Young's modulus, the material has high shock-absorbing properties and so is less liable to accidental damage.

Although the thermal conductivity of the aluminium alloy is much higher than that of mild steel and very much higher than that of cast iron, full advantage of this property cannot be taken because of the slow convection properties of the viscous cargo oils. However, the aluminium alloy pipes do have a greater heat transference rate than steel or cast iron, so that some economy of heating surface is achieved. With this in mind solid drawn seamless tubes having a bore of 2in and a wall thickness of 0·176in, were adopted. The addition of fins to increase the heating surface per lineal foot confers no advantage since this would entail a wider spacing of coils or a smaller bore pipe. The need for even heating of the cargo oil precludes the wider spacing of coils and the steam-carrying capacity of the smaller pipe is low in relation to the total heating surface. Another factor in favour of the plain round pipe is that it is easily cleaned and will not lose efficiency by reason of accumulations of sludge.

The pipes are prefabricated and the lengths are joined together by means of flanges of spigot and faucet pattern made of die-cast aluminium and arranged for a four-bolt connection. No welding is used to join the flanges to the pipes, the pipe material being expanded into grooves already cast into the flange. It is of special importance that each length of pipe is insulated from the next and the faces of flanges are separated by a phenolic resin gasket and the connecting steel bolts are insulated by means of ferrules, along the shank of the bolts, and washers under the bolt head and nut. Similar precautions are taken at each pipe support, which consists of a flat bar base and a flat bar clip of mild steel incorporating four studs fitted with "Tufnol" caps. The pipe is in easy contact with the insulating caps and is completely free to expand lengthwise and circumferentially. It has already been mentioned that the system has the same thermal efficiency as mild steel or cast iron heating coil systems and, based upon this, it is estimated by the company that, for a utility oil tanker of 16,000 tons deadweight, the aluminium alloy heating coil system is 55 tons lighter than the cast iron installation and weighs 32 tons less than a comparable installation in mild steel.

Extensions to Stockton-on-Tees Gasworks

A NEW gas carbonising and ancillary plant which was inaugurated at the Stockton-on-Tees gasworks on June 22nd has increased the daily gas producing capacity of the works by 4,000,000 cubic feet. This project originated in 1947, when the Stockton Corporation decided to increase the capacity of its existing works by the installation of a continuous vertical retort plant capable of producing some 2,000,000 cubic feet of gas daily. A contract for the supply of this plant was placed with the West's Gas Improvement Company, Ltd., of Manchester, which was at the same time required to provide foundations for an additional plant of similar capacity to be installed at some future date. At the same time as this contract was placed an order for a similar plant of the same capacity was placed by the nearby Middlesbrough Corporation for its Commercial Street works. This other order was also placed with the West's Gas Improvement Company, Ltd., and when in 1949 the Northern Gas Board took over administration of both of these undertakings it was decided to transfer the contract for the Middlesbrough plant to Stockton, where the projected increased capacity would be doubled.

The new plant comprises sixty-four continuous vertical retorts arranged in two benches of four settings. It is of West's "balanced heating" design with a nominal capacity of 4,000,000 cubic feet of gas a day. At present the coals being carbonised are Durham washed nuts, and the gas is being made at a calorific value of 500 B.Th.U. per cubic foot.

Coal is delivered to the plant by rail and transferred to a 21 tons capacity receiving hopper, whence it is delivered by a conveyor system to the feed belts arranged over coal storage bunkers serving the retort benches. These bunkers have a capacity of sixty hours' supply and are divided into eight compartments, each of which serves a setting of eight retorts. Outlets with slide doors lead to gastight coal valves of auxiliary feed hoppers, which open directly to the upper end of each retort.

In the Glover-West carbonisation plant the combustion chambers are arranged horizontally across the lines of retorts, each chamber being provided with its own separately controlled fuel gas supply. The temperature can therefore be readily distributed over the vertical length of the retort to suit the class of coal which is being carbonised. As required, the maximum temperature can be in the upper or lower chambers, or it may be evenly distributed over the whole length of the retort.

In the "balanced heating" system adopted producer gas is admitted to the combustion chambers from both sides of the setting and the products of combustion travel towards the centre line. The necessity for supplementary air is thereby eliminated and the retorts are heated by primary combustion.

The secondary air and the fuel gas supply ducts of the chambers are arranged in the outer walls of the setting. The products of combustion pass up the centre of the setting to the circulating chambers, where the preliminary heating of the charge is effected. Radiated and conducted heat passing from the centre of the setting is thus carried by the ascending waste gases to, and circulated within, the setting instead of being dissipated through the outer walls. Heat is also recovered from the outgoing charge of coke by circulating the secondary air round the bases of the retorts before delivery to the supply ducts.

Hot crude gas from the retort is washed by passing through a continuous spray of liquor returned at the correct temperature from a separating tank on the top of the pump house in close proximity to the retort house.

A sector extractor used for removing coke from the retorts cuts off a section of the coke monolith below the base of the retort at regular intervals of forty to fifty minutes. The sector table cuts the body of the coke in such a way that it fractures along its natural cleavage and it is then transferred to the coke chamber for further cooling before final discharge. When the table returns to its horizontal rest position the whole charge in the retort drops bodily about 18in on to the flat portion of the table.

Fuel gas is supplied to the settings from four of five "hot gas" mechanical producers. Two waste heat boilers are each capable of dealing with the waste gases from either of the two retort settings, and they generate steam at a pressure of 224 lb per square inch superheated to 450 deg. Fah. These boilers supply steam to two vertical 150 b.h.p. engines directly coupled to 100kW alternators, which supply power for the mechanical equipment of the works.

A new coke grading plant in a building adjoining the main retort house is equipped with bunkers having a capacity of 500 tons of screened coke.

Additional ancillary plant installed as part of this extension to the gasmaking capacity of the works includes a new dry purification plant, duplicate positive displacement exhausters, two multi-pass vertical water-tube gas cooling condensers, a tubular electro-detarrer, a multi-stage ammonia scrubbing plant, benzol and naphthalene washers, a four-lift 3,000,000 cubic foot capacity gasholder, and a concentrated ammonia liquor plant.

INTERNATIONAL PEAT SYMPOSIUM.—An International Peat Symposium is to be held at the College of Science in Dublin from July 12th to July 17th. The countries which will participate or send delegates to the conference include Belgium, Britain, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, The Netherlands, Norway, Sweden and the United States of America.

Investment Casting Works

WE recently visited the new works which have been opened at Droitwich Spa by Deritend Precision Castings, Ltd., for the production of small precision castings by the lost wax or investment casting process.

The firm was established in 1948, when it opened a small works in Birmingham. During the following three years, in addition to production of castings, it carried out a large amount of research and development work and training of staff in the techniques of precision casting. By 1951 it became evident that with the steadily increasing demand for precision castings by industry, a far larger productive capacity would very soon be required. It was therefore decided to lay down a new works in Vines Lane, Droitwich Spa, which would be fully capable of meeting current requirements with room for future extensions as, and when, they became necessary.

The new factory at present covers some 17,000 square feet, and in it the plant has been arranged to give a smooth production flow, whilst the arrangement is such that the layout can be readily adjusted when extensions are introduced. The present casting capacity is sufficient for 600 lb of metal a day on one shift, and for producing individual castings weighing up to 13·2 lb. With the techniques which have been developed, castings up to this limit can be produced to within overall tolerances of 0·005in and less on individual dimensions. The successful adoption of this technique of precision casting to obtain its fullest benefits is often closely tied up with satisfactory design of the casting, and for this reason the firm maintains a staff of consultant designers who work in close co-operation with the users of the castings. A particular advantage of the technique is, of course, the production of castings and awkward shapes in difficult metals to such limits that they require little or no further machining. Amongst the metals and alloys now being cast in an infinite variety of shapes by the firm are case-hardening steels, mild and medium carbon steels, medium carbon alloy steels, spring steels, austenitic steels, Nimonic alloys, martensitic steels, nitriding steels and many forms of tool and die steels.

Wax pattern making shop with wax injection moulding machine, inspection and trimming benches, and pattern assembly section

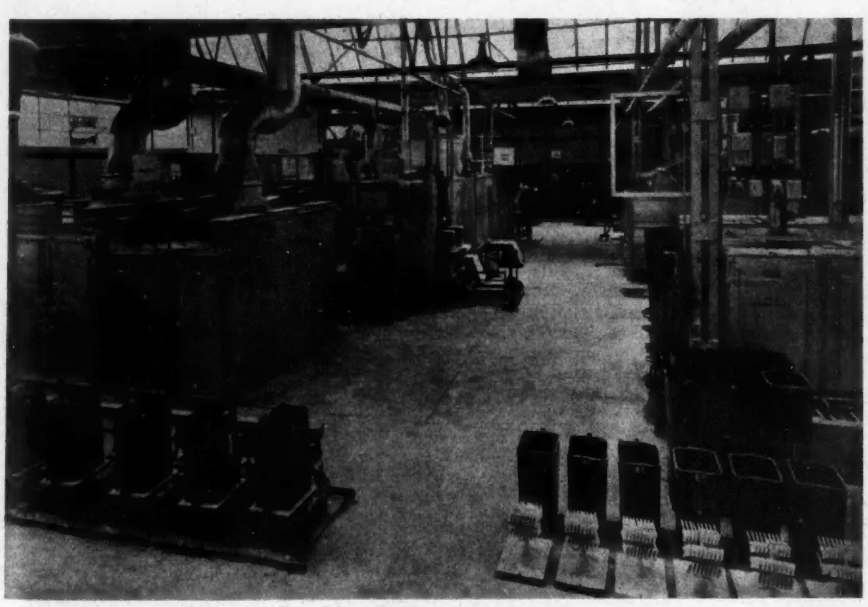
The injection dies from which the wax impressions used in the process are produced are made in a precision tool room in one of three forms selected in accordance with the requirements. The three forms of dies made and used here are the conventional sunk dies, fabricated or built-up dies, and tin-bismuth alloy cast dies. Before a die is issued for use it is subjected to close inspection, and a number of trial injections made to ensure that it complies with the required standard of accuracy and will maintain that standard in production working.

One end of the wax injection and assembly shop can be seen in a photograph on this page. The injections are made on four machines at one end and passed in batches to inspection and trimming benches in the centre of the shop. The small wax patterns are then welded by means of a hot iron on to a wax riser bar mounted vertically on a base plate, as shown in the illustration below.

As they are completed batches of patterns are transferred into the adjoining shop in one corner of which is a spray booth where the patterns are coated with a thin coating of highly refractory and finely divided ceramic. This coating is then backed by a coarser refractory before the patterns are transferred to a drying room. In the next stage, a metal container is placed over the pattern assembly and locked to the base plate, and a slurry of refractory material poured into the container to completely surround the wax assembly. This slurry consists of a high-grade refractory with a bonding agent, which is usually tetra-ethyl-silicate. The mould assemblies are then vibrated on tables until the refractory is packed and the mould is quite hard. The surplus liquid is then poured away and the container is placed in a drying oven for a few hours. During this period the tetra-ethyl-silicate hydrolises with free water present in the slurry, and a sticky silica gel is deposited all round the refractory particles to bond them together. After leaving the oven the container and base plate are stripped from the mould. In the foreground of one of our illustrations there can be seen a group of patterns and their containers and a number of the filled containers on vibrating tables. The drying ovens are immediately behind the vibrating tables.

Mounting wax patterns on wax riser bar on base plate

The moulds, after stripping, are placed in a second series of ovens, where the wax is melted and runs out of the feed head to leave the cavities of the required shapes. Final removal of all traces of wax is done by firing the moulds in an oxidising atmosphere in a continuous furnace, where the temperature is raised to 1100 deg.



Mould preparation, drying and firing shop with casting station at far end

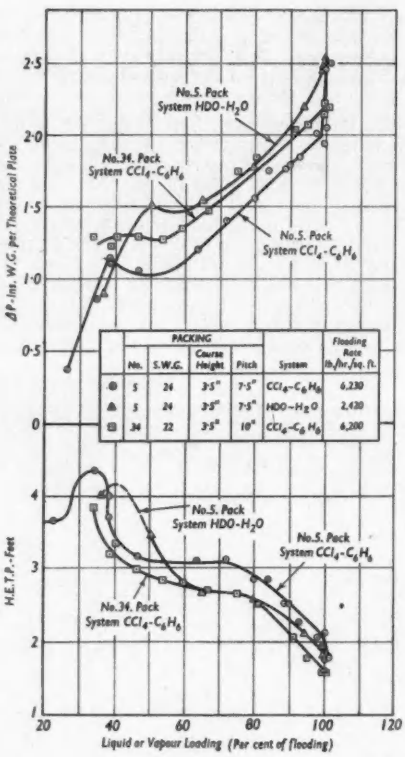
Cent. With the moulds at this temperature, they are cast on two stations at the far end of the shop. Here the precise amount of metal required for a mould is melted in a trunnion-mounted crucible, to which the mould is clamped, so that, on reversal, the metal enters and fills the mould. After cooling, the castings have all traces of the mould material removed on a vibrator before being passed out to the cutting-off and finishing shops.

The final inspection department is equipped for carrying out X-ray examination, crack detection, pressure testing and mechanical property testing according to customers' requirements.

Industrial Distillation Development

A NEW distillation column packing has recently been developed at the Atomic Energy Research Establishment, Harwell, primarily for the large-scale separation of the hydrogen isotopes by the distillation of water. Owing to the comparatively low value of the separation factor for this system (1·026 at 100 deg. Cent.) the primary requirements were a very large throughput, H.E.T.P. values of the order of 2ft or less, and a low first cost. The new packing, which has tentatively been named "Spraypak," fully meets these requirements and shows promise of wide application in industry.

Although distillation, undoubtedly the most important of the unit processes of chemical engineering to-day, is still carried out to a very large extent using bubble cap trays, which were first introduced more than 100 years ago, within the last few years a number of new kinds of distillation and absorption column fillings have been developed with the object of overcoming the inherent limitations of conventional packed and bubble plate columns. Some of these comprise modified forms of the bubble cap plate and perforated plate trays, designed to overcome inherent limitations such as the restricted throughput. Others, such as the "Turbogrid," the Kittell expanded metal tray, and "Panapak," a multi-layer expanded metal packing developed by Scofield, are simpler in that downcomers for the liquid are avoided, and a perforated grid, either flat or corrugated, is



H.E.T.P. and pressure drop data for Nos. 5 and 34 "Spraypak" at total reflux

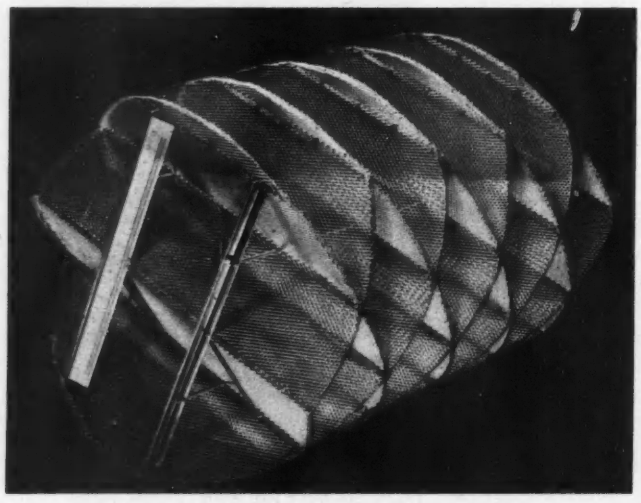
is shown in Fig. 1. The walls of each cell comprise separate Z-shaped pieces bolted, welded or clipped together to form a packing unit which is installed through the top of the column. Modified forms of construction are at present under consideration which will be suitable for installation through the manholes of conventional tower shells.

Investigations of the effect of variations in the type of mesh used and in the geometry of the packing have been carried out in a transparent air-water rig with a cross-section of 15in by 27in and a packed height of 4ft. Distillation tests have been carried out in a M.S. rectangular column of the same cross-section with a packed height of 20ft, using as test systems water slightly enriched in isotopic content, and also benzene-carbon tetrachloride. Air-water tests are also being carried out in a large air-water rig with a cross-section of 2ft 6in by 7ft 6in and a packed height of 10ft.

Experiments are stated to have shown the throughput is some 200 to 250 per cent of that of a well-designed bubble cap column with 18in plate spacing; thus, the flooding rate for the steam-water system is of the order of 2500 lb per hour square foot at atmospheric pressure. Typical H.E.T.P. and pressure drop data obtained with early forms of the packing are shown in Fig. 2. It will be noted that the curves of H.E.T.P. against throughput show a plateau in the range from about 50 to 80 per cent of flooding, so that the packing possesses a flexibility approaching that of the bubble cap tray.

At present it is not possible to assess accurately the cost of the packing as installed, since in any case this will to some extent be a function of the design. However, present indications are that the cost will be appreciably less than that of bubble cap trays for the same duty.

A licence to manufacture "Spraypak" in the U.S.A. has been granted to Denholme Incorporated, 211, W. 12th Street, New York, 11.



Distillation column packing

employed to produce a dense spray at regular intervals throughout the column. This spray serves the double function of providing a large surface for efficient contacting between vapour and liquid phases, and of making the system inherently self-distributing. It is probable that these fillings will show little or no diameter effect, i.e. reduction in efficiency with increasing column diameter.

"Spraypak" consists of a cellular structure made for most purposes from commercial ¼in nominal mesh 20–24 S.W.G. expanded metal of $\frac{1}{16}$in strand width. An example of a typical pack,

British Coal Utilisation Research Association's Annual Report

THE annual report for 1953 has been published by the Council of the British Coal Utilisation Research Association. There is an account of the more general activities of the association, followed by a review of research activity which is presented in three sections: Technical Research (Domestic), Technical Research (Industrial) and Laboratory Research. The work on domestic appliance research has been transferred to new laboratories and the report notes that although smokeless fuels offer the best hope of reducing smoke the study of the smokeless burning of bituminous coal is still being studied. Calorimeter rooms are being developed to give additional information upon the assessment of domestic appliances and field trials undertaken to give a check upon results. There are three sub-groups in the industrial research section of the report. That dealing with boilers notes the work of the field research team in the shell boiler field and comments that studies of heat transfer have indicated where inaccuracies may arise. Interesting results have also been obtained by experimenting with furnace tube baffles to influence heat transfer and raise boiler efficiency. Progress with the experimental cyclone combustor is duly noted and the report states that a coking stoker instead of a chain-grate stoker is now in use for testing the effects of fuel characteristics upon boiler efficiency. A programme on the fundamentals of under-feed fuel firing has been put in hand, and for the cleaning of hot gases for gas turbines recent development has been concentrated on a collector with a long, narrow tangential entry and outlets at both ends. A semi-technical scale pelleting plant, it is stated, has been designed and constructed and the gasification tests on pelleted slurry have yielded information regarding fuel distribution in the gas producer. The laboratory research section of the report deals with the combustion of coal volatiles and generally reviews progress of the work on deposits and corrosion, the assessment of dust in combustion gases and the work proceeding upon the grindability of coal.

Society of British Aircraft Constructors

AT a recent meeting of the council of the Society of British Aircraft Constructors, Mr. J. J. Parkes was elected president of the society for 1954/5 and Mr. C. F. Uwins was elected vice-president. Mr. H. Burroughes, who was president for 1952/4, becomes deputy president and Sir Frederick Handley Page was re-elected honorary treasurer. Mr. Parkes, who is chairman and managing director of Alvis, Ltd., and chairman of Alvis Mechanisation, Ltd., has been vice-president of the society since 1952, a member of the council since 1946, and a member of the management committee since 1949. In 1929 he joined Airwork, Ltd., as technical manager and test pilot; in 1935 he was appointed general manager of the de Havilland Aircraft Company, Ltd., Stag Lane, Edgware, where he worked until he joined Alvis, Ltd., in 1946. Mr. Uwins is managing director of the aircraft division of Bristol Aeroplane Company, Ltd., and director of the Bristol Aeroplane Company (Australia), Pty., Ltd. He was formerly chief test pilot of the Bristol Aeroplane Company, Ltd. He is the chairman of the society's test pilots' committee, and has been a member of the council of the society since 1952. The following were appointed to the management committee of the society: Mr. A. F. Burke, Mr. H. T. Chapman, Captain E. D. Clarke, Sir Roy Dobson, Mr. T. Gammon, Mr. W. T. Gill, Mr. H. G. Nelson, Mr. J. D. North, Mr. F. E. N. St. Barbe, Sir Frank Spencer Spriggs, and Sir Reginald Verdon Smith.

Form Generating Machine

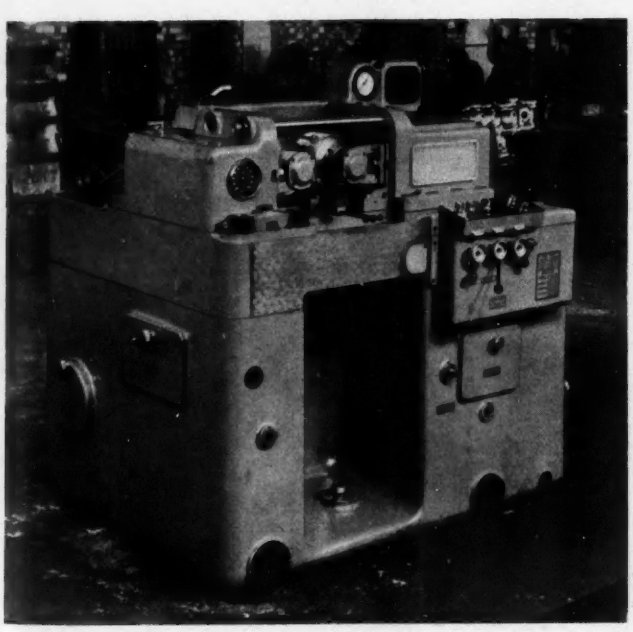
PARTICULARS have been received from B.S.A. Tools, Ltd., Birmingham, of a new form generator for rolling deep work such as acme threads, worm gears, multiple and tapered threads, &c., which it is now making. This machine is based upon the No. 3 thread rolling generator of Pee Wee Maschinen, Germany, and incorporates a number of modifications. It handles work between $\frac{3}{16}$in and 3in diameter and takes rolls up to 6½in diameter and 6½in wide.

The new machine, to be seen in the accompanying illustration, has a form of base construction in which the usual top " stretcher " is eliminated to leave the space above the rolls open, so that it can be readily adapted for magazine and hopper feeding. It incorporates provision for re-rolling on heavy components by a spindle reversing control mechanism ; an electronic timer which controls the dwell period of the operating cycle ; steplessly variable roll speeds, and its working pressure is variable up to 15 tons. The rolls in conjunction with the steplessly variable hydraulic feed provided give in effect an infinite die length and the rate of rolling can be closely controlled to suit the nature of the material being worked. The makers state that it can be used for forming a wide range of different materials including monel, invar, nickel-iron, copper and the nimonics that are generally considered unsuitable for thread rolling.

When rolling very deep forms it may be necessary to roll the component more than once and for this purpose a special re-roll mechanism has been incorporated in the machine to enable the spindles to be reversed automatically by the operation of a single lever. This spindle reversing control is so arranged that the rolling pressure is automatically reduced when the rolls are reversed and the pressure reapplied for the rolling operation. This action continues automatically until the correct depth of form is achieved, at which point the electronic timer trips out the hydraulic feed and the rolls are withdrawn. A B.T.H. electronic timer built into the machine is arranged to automatically time the dwell period of the roll slide at the end of the operating cycle.

In the gearbox and the roll-spindle mountings particular care has been taken to eliminate backlash, which can be most troublesome when rolling fine serrations. The two roll spindles are normally spring loaded in an endwise direction to give a degree of flexibility during rolling, and reduce the strain in the rolls. A device is incorporated on the machine for positively locking this lateral movement when fine serrations are to be rolled. An intermediate gear built into the gearbox is adjustable into mesh with the driving and driven gears and provides a means of taking up any backlash originating in the gearbox.

Movement forward of the right-hand roll slide is imparted by hydraulic pistons and it is returned by spring pressure. The valve mechanism controlling the hydraulic system provides for hand operation, semi-automatic or fully-automatic operation. The stationary left-hand roll spindle is mounted in a reaction bracket which can be swivelled to align the roll with the right-hand thrust roll, or set at an angle for rolling taper threads.



Form generator for components from $\frac{3}{16}$in to 3in diameter and suitable for magazine or hopper feed

Front elevation of the de Havilland Aircraft Company's new design offices at Hatfield

Aircraft Firm's Design Offices

WE illustrate herewith a new building which has been built for the de Havilland Aircraft Company, Ltd., at Hatfield, to accommodate the company's design and administration staff. It provides 78,000 square feet of office space ; each of the three floors of the building is laid out with 22,000 square feet of uninterrupted floor space, running the full length and width of the building (that is 473ft by a width generally of 46ft), which can be divided into separate offices by partitions. So as to give flexibility in the arrangement of the offices and partitions, the building is planned on a 2ft module

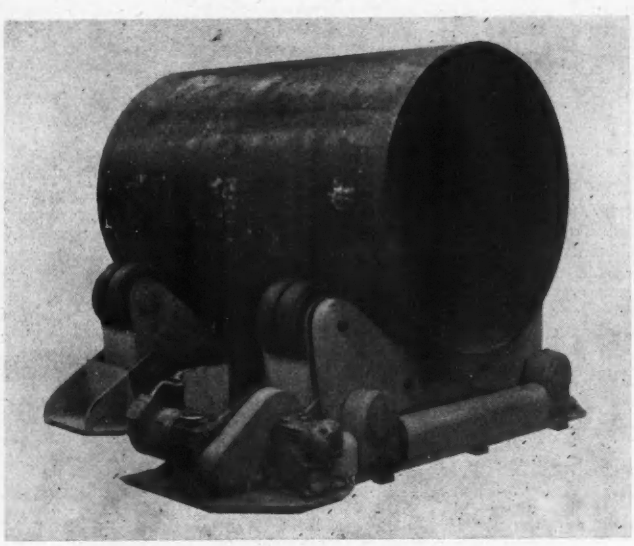
Preliminary designs for this building were prepared in May of last year. Work on the site started in the last week of July, and it was ready for occupation last month. The building has a structural steel frame and pre-cast concrete floor units and it was designed by James Monro and Son, and built by Bovis, Ltd.

Rotators for Cylindrical Welding Work

A NEW piece of equipment for rotating cylindrical work from 2ft to 12ft diameter is now being made for use in welding shops by F. Bode and Son, Ltd., Buxton Road, Leek, Staffs. These rotating rolls are made in a number of sizes to take work weighing from 10 tons upwards, and one of the 20-tons capacity sets is illustrated below.

The 20-tons equipment is built in two sections, one of which is power driven and the other an idler, each with eight twin, 15in diameter, 5in wide rubber-tyred rollers. These rollers are in full contact with cylindrical work up to 4ft diameter, and the inner rollers only engage work under that size. The roller axles are arranged at fixed centres in their supporting brackets on both the power and idler sections ; and the brackets themselves pivot on trunnion shafts carried at fixed centres in the frame. This arrangement enables the roller brackets to automatically align themselves to the workpiece without need for adjustment when loading the rotator.

The driving rolls are driven through reduction and variable speed gearing by a small electric motor and the transmission is normally arranged to give a range of speeds from 3in to 17in per minute.



20-ton welding rotator for cylindrical work from 2ft to 12ft diameter

The American Scene

(By Our American Editor)

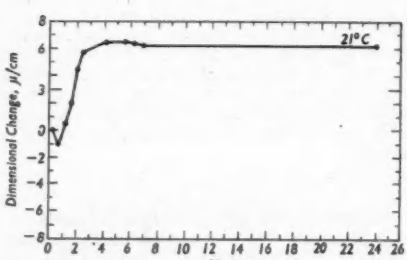
Dimensional Changes in Dental Amalgam

ALTHOUGH silver alloy amalgams have been widely used in dental restorations for over a hundred years, the metallurgical processes involved in the hardening of these materials have never been completely understood. This is particularly true of the reactions responsible for the dimensional changes which occur during and immediately following solidification. Recently, an interesting new approach to the problem was made at the National Bureau of Standards, Washington, D.C. Through the use of X-ray diffraction techniques at low temperatures, the dimensional changes occurring were correlated with the presence of uncombined mercury in the alloy after its initial hardening. From the data obtained, a basic mechanism for the dimensional changes has been proposed, and it is felt that the increased understanding which has been brought to the problem should lead to the development of improved dental amalgams and better methods for their application.

The silver-tin-copper-zinc amalgam commonly used in dentistry is prepared for insertion in a tooth cavity by mixing from 3 to 4 parts of mercury with 2 parts of a powdered alloy containing approximately 70 per cent silver, 25 per cent tin, 0·6 per cent copper, and 0·2 per cent zinc. The resulting plastic mix is divided into small segments, excess mercury is removed from the segments by finger pressure, and each segment is then packed into the cavity. The compositions of dental amalgam alloys have been empirically adjusted, so that as the amalgam hardens it expands slightly and locks the restoration into the tooth. In past experimental work it was shown that the dimensional changes occurring after the mixing of the alloy with mercury depended upon a number of different factors, such as the composition of the alloy, the alloy-mercury ratio, the method of mixing and packing in the tooth, and the temperature. However, until now no satisfactory mechanism had been proposed to explain the initial contraction, subsequent expansion and final contraction of the amalgam which take place within the first twenty-four hours after amalgamation. Attempts to describe these changes in terms of mercury content have been unsuccessful because chemical analyses could not distinguish between combined and uncombined mercury. X-ray diffraction studies have been made, but the data obtained in this way gave no information on the possible presence of uncombined mercury at various stages of the process, since, at room temperature, the free mercury in the amalgam has no crystalline structure. To determine the part played by the uncombined mercury in the dimensional changes of the amalgam, the Bureau decided to undertake a study of dental amalgam by X-ray diffraction methods at liquid nitrogen temperatures. In this temperature range any uncombined mercury would be in the solid state and would thus have a crystalline structure. Primarily, the investigation sought to answer three questions: (1) Is uncombined mercury present after the amalgam has hardened? (2) If uncombined mercury is present, does it continue to take part in any reaction? (3) If so, can the dimensional changes which occur in hardened amalgam be correlated with this reaction?

Experimental Work at N.B.S.

Specimens were prepared by mixing mercury and amalgam alloy, and then packing the resulting mass in a stainless steel combination mould and specimen holder. The procedures used resembled the methods of clinical dentistry as closely as possible. The steel mould was enclosed in a cylindrical chamber which could be alternately cooled to −125 deg. Cent. by admission of liquid nitrogen and warmed to mouth temperature (+37 deg. Cent.) by a resistance coil. The temperatures were measured with an iron-constantan thermocouple. The condensed amalgam specimen was kept in the mould and was attached immediately to the shaft of a high-angle spectrometer goniometer. The introduction of liquid nitrogen into the chamber surrounding the mould reduced the temperature of the amalgam specimen below the solidification point of uncombined mercury, and this low temperature was kept constant while an X-ray diffraction chart record was made. The specimen was then warmed to mouth temperature and maintained at that temperature for a specific ageing period, after which the process was repeated. This alternate freezing and warming of the amalgam specimen was continued for twenty-four hours in order to follow any chemical changes which might occur. Meanwhile, the corresponding dimensional changes on comparable specimens were observed on a dental interferometer kept in a temperature-controlled



Dimensional changes occurring during hardening of dental amalgam. The initial contraction and subsequent expansion can be seen

air bath. The accompanying graph shows the dimensional changes which occurred during the hardening of dental amalgam at 21 deg. Cent. An analysis of the X-ray diffraction charts showed that uncombined mercury was present in the amalgam and that this mercury disappeared with time, as indicated by the reduction in the height of the mercury lines. The decrease in uncombined mercury was accompanied by a disappearance of the lines representing the original alloy particles and an increase in the alloy-mercury phases of Ag_2Hg_3 and Sn_7Hg. The data show an almost complete disappearance of the mercury lines within six hours, a period corresponding generally to the time during which expansion and contraction of amalgams are commonly observed.

Conclusions

From the data obtained, it appears that the initial shrinkage observed during the hardening of amalgam results from the reaction of mercury with the alloy to form compounds having a smaller volume than that of the original alloy and mercury together. The subsequent expansion is caused by diffusion of uncombined mercury throughout the material, and the final shrinkage then results from the combination of this mercury with existing phases or with residual alloy. On the basis of this explanation, a reduction in the size of the alloy particles or a heat-treatment which would make the particles more reactive would tend to cause a reduced expansion or even a net shrinkage of the amalgam. The theory proposed by the N.B.S. might well account for the undesirable shrinkage of amalgam which occurs from excessive grinding or working of the material when it is being packed into a cavity. Such treatment would tend to reduce the amount of uncombined mercury, either by furnishing new reactive surfaces or by actual mechanical removal of the mercury. It would also tend to distribute the uncombined mercury throughout the amalgam so that there would be fewer mercury-rich areas from which diffusion could take place.

Space Heating Applications of Solar Energy

As a result of research work sponsored by the American Society of Heating and Ventilating Engineers at the University of Minnesota, a report has been issued outlining certain possible space heating applications of solar energy. The work has indicated that the desirable orientation for a solar-energy collector appears to be a south-facing vertical position. In regard to the availability of solar radiation incident upon a south-facing vertical surface in the United States during December and January, the maximum radiation available appears to be in the States of Colorado and New Mexico. A reasonably uniform radiation exists in the Mississippi Valley region and the Pacific north-west and the regions immediately south and east of the Great Lakes are characterised by low amounts of winter sunshine because of excessive cloudiness. Of the total daily radiation incident upon a south-facing vertical surface outside the atmosphere during December and January at 42 deg. north latitude, about 45 per cent was found to be depleted by the atmosphere during the cloudless days. The records of the U.S. Weather Bureau show that the total radiation incident upon a horizontal surface at a given site varies widely from year to year and that negative deviations from the average of 30 per cent may be expected. These records also show that at many localities sequences of winter days with above-average radiation are more common than sequences of days with below-average radiation and that very dark winter days when little solar energy may be collected are commonly days with above-average temperature. On the other hand, very cold days are usually days with above-average incident radiation.

It has been established that any solar heating system must include a heat storage facility if solar energy is to contribute more than a token part of the space-heating requirements of a building. Because of their large heat capacity per unit volume and large heat capacity without large temperature change, heat-of-fusion storage materials appear to be superior to storage materials based on the specific heat or latent heat of vaporisation. The report includes a design procedure for estimating the collector area, the heat-storage volume, the heat-pump specifications and the auxiliary heating capacity of a solar heating system. This procedure may be used for any locality for which the proper solar statistics are available. Thus, at Lincoln, Nebraska, a locality having rather severe winters, a house having a design heating load of 62,000 B.Th.U. per hour may be heated during average winters with a system equipped with a collector having a surface of 700 square feet, a 4 h.p. heat pump and a heat-storage facility using 460 cubic feet of a heat-of-fusion storage material placed on the evaporator side of the heat pump.

In many localities, solar-energy heat-pump systems would result in lower heating costs at the present time than conventional fuel-fired systems. With the steady depletion of the world's petroleum resources, it is reasonable to expect the relative operating economy of solar-energy heat-pump systems to be more favourable in the future. At present, such systems would have a high first cost, but with the standardisation of collectors and heat-storage units, it would be possible to reduce these costs. It is felt that the

main problems associated with the development of solar-energy heat-pump systems involve the solar collectors and the heat-storage systems. No serious architectural problems appear to exist since a house may be designed to include a moderately large south-facing collector and yet retain architectural appeal and "liveable" qualities equal to those of conventional homes. Solar-energy heat-pump systems appear feasible in a large part of the United States, but further research and development is necessary before such systems can be adopted on a large scale.

Use of Solderless Wrapped Circuit Connections in the American Telecommunications Industry

An interesting jointing method for connecting wires to the terminals of apparatus has been developed jointly by the Bell Telephone Laboratories and the Western Electric Company in America. The new technique not only eliminates soldering, but also has been found to reduce costs, improve quality and conserve space. In contrast to the soldered joint, which depends largely upon human judgment and skill, the wrapped connection is made with a calibrated tool, pneumatically or electrically driven, resulting in a degree of joint uniformity that makes final inspection almost unnecessary.

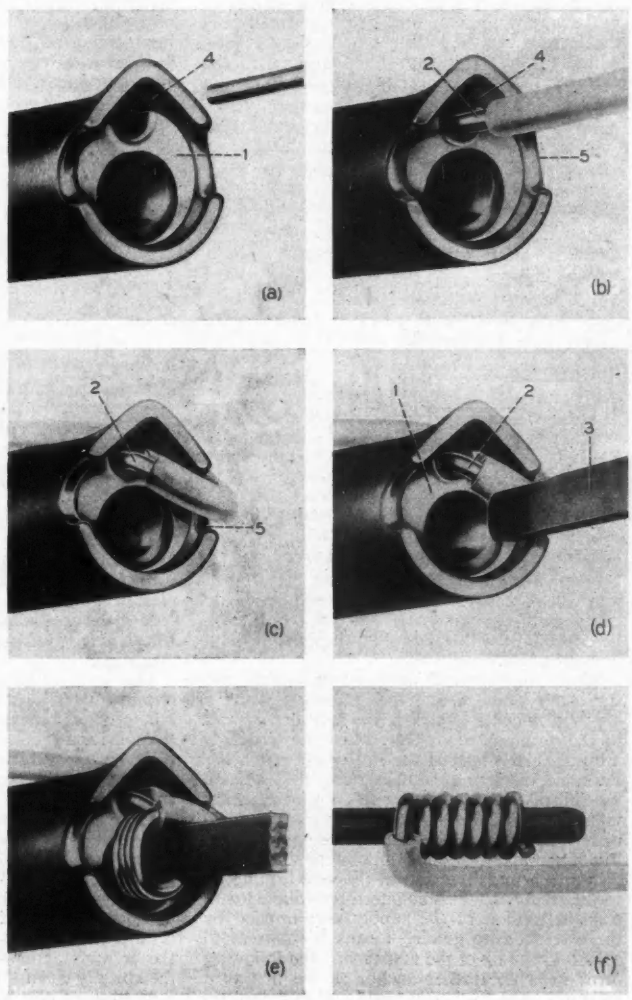
IT has been estimated that in the American telephone industry during the course of a single year, the operation of connecting a wire to a metal terminal is carried out approximately 1000 million times. Many of these connections are made in the factory, others are made during the installation of equipment and a substantial number are made in the course of normal operation of the telephone plant. The successful functioning of the equipment depends on the trouble-free performance of each of these connections, which are nearly all soldered in accordance with long-standing practice. Recently, a new technique for joining wires to terminals has been developed jointly by the Bell Telephone Laboratories and the Western Electric Company. The immediate need for a new method of connection arose from the design of a new wire spring general-purpose relay. In this relay the terminals appear in the form of closely spaced

Fig. 1—Wire wrapping tool in operation

wires and the standard methods of applying connections were found to be unsatisfactory. Since the production schedule for these new relays required something like 50,000,000 connections a year on relay terminals alone, an intensive effort was made to devise a satisfactory method for wiring. The first result was the development of a tool which could wrap a few turns of wire around the terminals of the relay, and do this efficiently on the closely spaced wire terminals. It was soon found that similar tools could be used to advantage on existing designs of terminals, and the Western Electric Company is now making extensive use of wrapping tools. However, the connections made with these tools are being soldered after wrapping. In the meantime, further development work indicated the possibility that by wrapping the wire under tension around a properly shaped terminal, the need for soldering might be eliminated. Major economies appeared possible if such a solderless wrapped connection were applied extensively in wiring communications equipment. In addition, it was realised that there would be freedom from trouble due to solder splashes in equipment and that there would be an appreciable reduction in the consumption of tin for use in solder.

In nearly all soldered connections where a wire is to be joined to a terminal the joining procedure is as follows:—The operator takes the skinned end of an insulated wire, hooks or threads it on to the terminal and applies solder. The hooking or threading is important because it is customary in production to attach several wires at first and then to solder. If a similar procedure was to be followed with a wrapped connection where the wire must surround the terminal with a high pressure, the problem was how to produce that pressure conveniently. In a screw connection, a force is obtained by a high lever ratio. In a crimped connection the force is applied by heavy and powerful compression tools. These tools are not suitable for connecting wires to closely spaced terminals. Thus, to produce high tension in the wire while it is being wrapped on to the terminal, a new method of tensioning had to be developed, and the pneumatically driven wiring tool, which has resulted from this work, is shown in operation in Fig. 1.

In the manufacture of helical springs it is customary to anchor the end of the wire in a hole in the arbor and to tension the wire with a friction pad. By rotating the arbor a helical spring is produced. It was found that for closely spaced terminals this method is not practical as the wire cannot be fed tangentially to the terminal and the terminal cannot be rotated. A new wire connecting concept was, therefore, proposed in which a rotating spindle housed a stationary terminal in an axial opening in the spindle and was provided with a second opening radially separated from the axial opening and arranged to accommodate a wire. When the spindle was rotated the wire was caused to form a spiral about the stationary terminal. One method involved anchoring the wire in the second opening and feeding the wire tangentially to the terminal as the spindle was rotated. Due to certain limitations inherent in tangential feed on to a stationary terminal an improved method was finally chosen. This is the so-called axial feed method which is particularly suitable for the wrapping of closely spaced terminals of all cross sections. The six stages involved in loading the wire and wrapping the connection are shown in Fig. 2. Position *a* shows the tool tip ; position *b* the bare wire 2 inserted into the feed slot 4 ; position *c*, the anchoring of the wire by bending



(*a*)—Tool tip.
(*b*)—Wire inserted.
(*c*)—Wire anchored.
(*d*)—Terminal inserted.
(*e*)—Wire wrapped.
(*f*)—Finished connection.

Fig. 2—Stages of wire wrapping process

it into the notch 5; position *d*, the terminal insertion; and position *e*, the wrapping of the wire 2 by rotating the spindle 1 around the terminal 3. Position *f* is the finished connection.

The tension in the wire is produced by rotating the spindle 1 around the terminal 3, thus pulling the short bare wire 2 out of the feed slot 4. In the process of pulling the wire out of the slot and wrapping it around the terminal each increment of the bare wire length undergoes several bending operations. The first bending occurs at the edge of feed slot 4 where the wire is bent through an angle of less than 90 deg. The second bending is the straightening out operation of the bent wire. The third bending takes place as the wire is wrapped around the terminal. All three bending processes contribute to the tension with which the wire is wrapped. The dimensions which control the tension and are therefore of importance in design are the radius *R* at the tool tip and the wall thickness *W*, as indicated in Fig. 3. The bending forces are inversely proportional to the respective bending curvatures and the frictional forces in turn are proportional to the bending forces. The tension imparted to the wire as it is wrapped around the terminal, however, is not only due to the friction alone, but to the combined effect of friction and bending effort. If the wire were completely elastic and the friction zero, no tension could be produced. But there would be tension in the wire if the friction were zero and the wire only partly elastic such as copper wire. There also would be tension if a completely elastic wire would be pulled around an edge having friction.

When the edge radius *R* of the wrapping tool is too small, very high tension can be developed in the wire while wrapping. At very small radii the tension can be sufficient to break the wire. Although wrapping with high tensions in the wire produces a connection which will sustain very high stripping force, the wire is so embrittled that under vibration and handling it may break easily. A practical and generally easily met requirement is that the connection be capable of withstanding unwrapping without wire breakage.

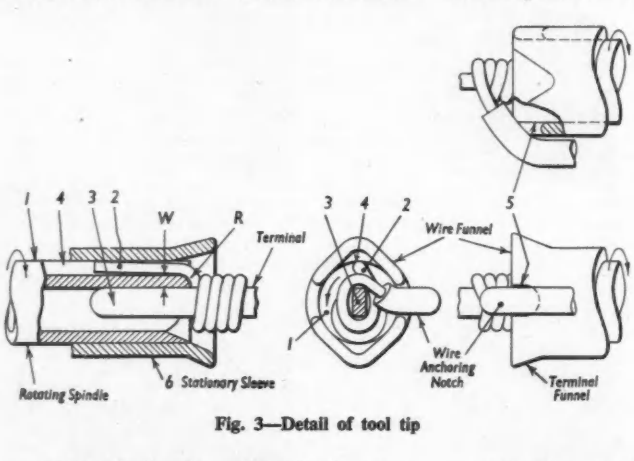


Fig. 3—Detail of tool tip

When the terminals are closely spaced, the stationary sleeve 6 and the anchoring notch 5 are used in order to anchor the first turn of wire to the terminal. However, when the terminals are not closely spaced the sleeve and notch are desirable, but are not necessary since the insulated portion of the wire can be held by some means independent of the tool at an angle of approximately 90 deg. with respect to the tool spindle. The high acceleration of the wrapping motor produces a mass reaction of the wire leading up to the terminal. This counterforce coupled with a slight tension of the supply wire applied by the external wire guiding means is sufficient to ensure wrapping of the first turn. The following turns need no further anchor as the first turn locks the wire to the terminal. With a tool tip such as the one shown in Fig. 3 it is possible to wire apparatus having a terminal spacing as close as two and a half times the terminal width. It has been found possible to wire a terminal block 1¼in by ¾in by $\frac{5}{16}$in having forty-four terminals with forty-eight 0·0159in diameter wires by this wrapping technique.

The solderless wrapped connection may be removed from its terminal by two methods. The most convenient method is by stripping. For this purpose the specially formed jaws of a pair of pliers are hooked at the back of the connection, and by applying a force the connection may be stripped off. Another method of removing a connection is by unwinding the helix. This may be done by using a pair of pliers and either end of the wire may be used for unwrapping. A terminal is not seriously damaged by stripping off a wrapped wire; however, the re-use of the stripped off wire is not recommended. A wire may be reconnected by skinning to the proper length and wrapping. When the wire is not sufficiently long to provide the necessary number of turns to ensure a good connection, one or two turns may be wrapped and then soldered.

It has been found that there is no upper limit to the size of wire wrapped on adequately proportioned terminals. Connections have been made with both aluminium and copper wire over 0·200in in diameter with satisfactory results. The torque necessary to wrap large wire is considerable, since it increases with the third power of the diameter. A 0·020in wire requires a winding torque of 100 inch-grammes, whereas a 0·200in wire requires 100,000 inch-grammes, or 18 foot-pounds. Wires as small as 0·0035in diameter have been wrapped; however, the design of the wrapping tool had to be changed slightly in order to facilitate the loading of the fine wire into the tool. The terminal width most frequently used in conjunction with the common 0·020in copper wire is about $\frac{1}{16}$in, or three times the wire diameter. When smaller wires are used the tendency is to make the terminal width greater than three times the wire diameter to obtain better visibility. The terminal thickness depends to a great extent on the shape of the terminal. For a rectangular terminal the thickness may vary from three times to one-half the wire diameter. When the terminal thickness is less than one-half the wire diameter, the terminal may twist too much during the wrapping operation.

The rectangular terminal is not the only terminal which lends itself to wire wrapping, but, generally speaking, it has been found most suitable for a good solderless wrapped connection. It is an inexpensive terminal since it can be blanked from sheet or coined from round wire. It is ideally suited for a pressure connection because the edges produce a concentrated high pressure on the wire. The stress distribution in the wire produced by the terminal edges is shown diagrammatically in Fig. 4. If the wire is wound with high tension around the rectangular terminal the terminal edges dig into the soft copper wire, crush and shear the oxide on both the wire and the terminal and form a large, intimate and metallically clean "gastight" contact area. An indication of the high pressures prevailing has been the crushing of hard nickel silver terminal edges by soft copper wires. Several turns of wire are required to preserve this high contact force. In general it is assumed that the first and last two edges around which the wire is wrapped do not contribute much to the joint as contact areas. A seven-turn wrapped connection on a rectangular terminal thus has six effective turns. Each turn contacts four edges or a total of twenty-four contact areas for six effective turns. The quality of the connection obtained depends fundamentally on two factors: the contact area and the contact pressure. As long as there is sufficient pressure and the atmosphere cannot enter the joint, the connection is considered to be a good one. If, however, the elastic energy which holds the two surfaces together is small, various disturbances may cause a partial separation of the interlocking metal particles and thus effect a change in resistance. For normal telephone applications a good connection has, therefore, been defined as one which not only has sufficient contact area and contact pressure, but which also has sufficient elastic reserve to maintain contact area and contact pressure throughout the desired life of the apparatus in question, which may be forty years or more.

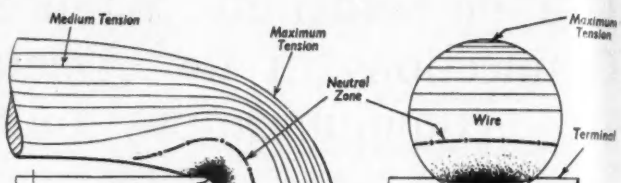


Fig. 4—Stress distribution in wrapped wire

By methods of photo-elasticity and strain analysis it has been demonstrated that the wrapped solderless connection is held together by the hoop stress in the outside wire whose value is determined by the winding stress and the locking in effect dependent on a dissymmetry of the terminal. The high stresses cause plastic flow in the wire and terminal in such a manner that the two materials flow together and produce an intimate airtight joint. The intimate nature of this contact has been demonstrated by dip coating nickel silver terminals with pure tin and wrapping them with cleaned bare copper wire. The wrapped terminals were then placed in a glass tube, evacuated, sealed off and heated for 400 hours to 180 deg. Cent., 37 deg. Cent. below the melting point of tin. The samples were then removed, mounted vertically, polished, etched and examined microscopically for distinguishing constituents. It is believed that if such a constituent appeared on the originally bare copper wire after such treatment, the contact was sufficiently intimate to permit solid state diffusion. The copper was seen to have a heavy layer of tin constituent at the contact surface. From this test it was concluded that wrapped connections made in this way are sufficiently tight to allow solid state diffusion and are, therefore, good electrical contacts.

On the other hand, the contacts are not welded contacts such as occur when two pieces of aluminium are cold pressed together with strains in excess of 75 per cent. This is shown experimentally by the simple process of unwinding the wire from the terminal which takes place with no excess force when the wire is removed from a terminal corner. Since the strains at the points of contact do not exceed 30 to 40 per cent, one would not expect cold welding. It is possible, however, that in tinned terminals some long-term diffusion takes place at room temperature in the manner demonstrated at higher temperatures by the above test. This would, however, occur very slowly and cannot be relied upon solely to maintain the contact.

It is stated that the Western Electric Company does not intend to produce the wire-wrapping tools itself. The firm does, however, plan to make the tools commercially available to manufacturers of telecommunications, wireless and television equipment.

Industrial and Labour Notes

Industrial Productivity

The British Productivity Council has published this week a pamphlet entitled *Why Productivity ?* It is the first of a series of such pamphlets, the purpose of which, the council says, "is to disseminate as widely as possible a general knowledge of techniques that can assist in achieving a continuous increase in productive efficiency." The pamphlets will, it is hoped, provide a statement of the principles involved, the methods by which they can be applied, and the benefits which will result.

The text of the pamphlet reviews, in simple language, the present economic background, and in so doing naturally reiterates many statements that have been made before. It again stresses the need to derive more from existing resources, commenting that "some methods of work result in more products from the same amount of labour." Far too many people in industry, the pamphlet says, are still working less effectively than they might because their jobs have never been systematically studied and planned from the start. That improved productivity is possible, the pamphlet maintains, is borne out by a simple comparison between various countries. The average British worker, it is noted, produces nearly twice as much as the Italian, and the average American worker produces between two and three times as much as the British. Most of the reason for the American's superiority, the pamphlet continues, is the amount of machinery he has to help him, there being "8 horsepower behind every American worker, but only 3½ behind every British worker." Much of the remainder, it is suggested, is accounted for by a better use of techniques for the organisation of production. All these techniques, the pamphlet comments, are known here, but they are not used so intensively or widely. The most efficient firms in this country, it is added, are just as good as the best in the U.S.A.; it is the average here that is lower.

The British Productivity Council hopes that this pamphlet, and those which are to follow in the new series, will be of use to all who are willing and able to assist in the improvement of that efficiency in production on which the future prosperity of the country depends. The pamphlets will be distributed through local productivity committees and any other appropriate organisations.

Iron and Steel Production

The British Iron and Steel Federation has included in the latest issue of its *Monthly Statistical Bulletin* a survey of the progress of the British iron and steel industry during the first six months of this year. It says that that period has been an active one for the industry, and has been marked by a steady advance in steel production, happily unhampered by any raw material shortages or labour difficulties, and by a sustained advance in home consumption. There is no sign that this advance is likely to lose its momentum, and the iron and steel industry therefore looks forward to maintaining its activity at a high level in coming months.

In each month of this year, steel output has been well above that for the corresponding month of 1953. At the time of going to press, the final production figures for June have not been published, but the output of steel ingots and castings in the first twenty-three weeks of the year amounted to 8,404,000 tons, and the total for the six months is expected to be about 9,500,000 tons. This represents a 5 per cent increase which, if applied to the full year's result for 1953 (17,600,000 tons), would imply a total of 18,400,000 tons for 1954. But, the *Bulletin* recalls, last year's steel output was depressed in the second six months by a number of mischances at various works, and the performance this year to date, it is suggested, is not inconsistent with a final 1954 figure of 18,500,000 tons or even slightly more. The *Bulletin* goes on to say that this year's improvement, compared with 1953, is mainly accounted for by higher outputs in four steel-making districts, South Wales, the North-East Coast, Lincolnshire and Lancashire, and that, to some extent, these district increases are a reflection of the expansion of steel and iron-making capacity. Assisted by the growth of blast-furnace capacity and higher imports of iron ore, pig iron production has also been running at record levels. The output for the first half of this year is likely to be 5,970,000 tons, or 7½ per cent more than in the first half of 1953. The increased supply of iron, together with a well-maintained flow of scrap from home sources, has, of course, provided the indispensable basis for the continued expansion of steel production.

The rise in the home production of steel has made possible a further reduction in imports, which are estimated at about 290,000 ingot tons during the first half of this year, compared with 600,000 tons in the corresponding period of 1953. The total supply of steel, which takes account of second-hand and re-usable material and changes in producers' stocks, is reckoned to have increased from 9,645,000 tons in the first half of 1953 to about 10,000,000 tons in the first half of this year. In recent months, steel exports have been running at much the same level as in the first half of 1953. The *Bulletin* explains that most of the official restrictions on exports have now been lifted, but says that overseas demand has shown little expansion, whilst competition from other steel exporters has been keen. Virtually the whole of the increase in total supplies, therefore, has been available for use at home. The shortages of particular products have now been largely overcome and delivery periods are greatly improved. So far as plates are concerned, a 5 per cent increase in production and a slight reduction in exports have combined to raise still further the level of home deliveries compared with the first half of 1953. The British Iron and Steel Federation says that the demand for plates can now be met from home sources ; imports of plates, which in the early months of this year were much the same as in 1953 are now insignificant. The only finished steel product now being imported in any quantity is sheet (in particular, cold-reduced sheet).

Index of Industrial Production

The index number of industrial production (1948=100), which is prepared by the Central Statistical Office of the Treasury, has been estimated as 124 for all industries in April, compared with 130 in March. Figures for the corresponding months of 1953 were 117 in April and 124 in March. In both years, the April figures were affected by the Easter holiday period. A closer analysis of the figures shows that in April this year, the index for mining and quarrying was 106, compared with 111 in April, 1953, and that for the manufacturing industries was 127 compared with 119 a year earlier. The Treasury says that on the basis of information so far received the index for all industries in May this year is expected to work out at 131 or 132. The index number for May last year, which month included the Whitsun holiday, was 123 for all industries.

Industrial Production in Europe

A report which has been prepared recently by the Organisation for European Economic Co-operation says that, during the second half of last year, the recovery of industrial production in Europe gained in strength. Moreover, the progress already achieved towards balancing external payments, particularly with the dollar area, was consolidated. In most countries, the report notes, economic activity expanded last year without any sign or threat of inflation. The report goes on to comment that, although since last summer the U.S.A. has been passing through a period of readjustment, similar in scope to the 1949 recession, international trade and the level of activity in Europe and in many other parts of the world have so far been very little affected.

The report states that industrial production in Western Europe has now emerged from the stagnation which was marked in 1952. As a result of the steady progress made, the industrial production index for all O.E.E.C. member countries during the last quarter of 1953 was 8 per cent above the peak attained in the boom following the outbreak of war in Korea. Furthermore, the data so far available for the first two months of 1954 suggest that production is still expanding. The figures given in the report show that between the second half of 1951 and the second half of 1953, the increase in industrial production was 19 per cent in Germany, 17 per cent in the Netherlands, 16 per cent in Italy, 5 per cent in the United Kingdom and in Austria, and 1 per cent in Sweden. In France and Belgium, however, production was 1 per cent lower in the second half of 1953 than in the second half of 1951. The report explains that production in Italy and the Netherlands has been recovering since mid-1952. In France, recovery has only quite recently begun, whilst in Germany expansion has been resumed after "a barely perceptible slowdown." For most countries, and for O.E.E.C. member countries as a whole, the rate of expansion is still slower than during the period of reconstruction and the boom which followed the outbreak of war in Korea, but, the report observes, it is now accompanied by internal financial stability. For 1953 as a whole, industrial production showed an increase of 4½ per cent compared with 1952.

During last year, the report says, expansion was greatest in the consumer goods industries which were those most affected by the 1952 recession. While the basic industries, and more particularly iron and steel, continued to prosper in 1952, their activity was slowed down in most O.E.E.C. member countries last year. Thus, it is stated, there is idle production capacity in the mechanical and electrical engineering industries, and, for all states of the Coal and Steel Community, in the iron and steel industry.

Copper Supplies and Prices

The annual general meeting of the British Non-Ferrous Metals Federation was held in Birmingham on Thursday of last week, when Mr. W. F. Brazener was elected president. Mr. H. C. Gibbins and Mr. C. E. Prosser were elected vice-presidents.

Following the custom of the Federation, a report on the past year's activities was presented by the retiring president, Mr. H. E. Jackson. In the course of it, Mr. Jackson said that during the first eight months of 1953 the output of semi-finished products of copper and copper-base alloys dropped steadily each month. From September, the situation began to improve though the average monthly figures for the whole of 1953 were well below the equivalent figures for 1952. Since last September, Mr. Jackson stated, the average output of semi-finished copper products and copper-base alloys had been about 45,000 tons a month. There was some unevenness in the state of trade, and some firms had continued to stress the tendency of customers to buy short in the belief that copper prices would decline.

Mr. Jackson went on to comment on the fact that the price of copper had remained high. Before decontrol, the Ministry of Supply selling price was £252 a ton. With the reopening of the London Metal Exchange (for copper) on August 5th last, the price fell sharply to £216 a ton, but it rose rapidly again until it reached, towards the end of October, a figure of £247 10s. At the beginning of this year, there was another sharp decline to £216 a ton, and then a further steady rise until a figure of £250 a ton was reached in mid-April. In the last couple of months copper prices had remained high—round about £240 a ton—but there had been a noticeable and welcome narrowing of the "backwardation" to a figure of about £2 a ton. Mr. Jackson thought that it was to be regretted that at a time when the Exchange quotation certainly could not be criticised for being too low, some producers should still wish to charge a premium.

Notes and Memoranda

Rail and Road

ROAD ACCIDENTS IN APRIL AND MAY.—A report of the Ministry of Transport and Civil Aviation states that just under 20,000 casualties occurred on the roads of Great Britain in May, and this includes 372 killed and 4755 seriously injured. Final figures for April, just issued, give a total of 17,497 casualties—394 less than in April last year. A feature of the figures, which is becoming increasingly noticeable, is the number of casualties to riders of motor-assisted pedal cycles. In April these casualties numbered 208, which, although small in relation to other casualties, is forty more than in April, 1953. Casualties to other motor cyclists increased by 116 to 2842.

Air and Water

LAUNCH OF LIGHT VESSEL.—Light Vessel No. 16, under construction for the Corporation of Trinity House, was launched on July 1st from the Noss works of Philip and Son, Ltd.

STEEL PONTOON FOR GRAIN ELEVATOR.—A steel pontoon for a grain elevator, M.O.T. No. 4, was launched by J. Samuel White and Co., Ltd., on July 1st. The pontoon is 87ft 6in long by 37ft 6in beam and 15ft deep, and the elevator will have a capacity of 200 tons per hour.

DIESEL ENGINE SERVICE DEPOT.—A stores and service depot for British Polar Engines has been completed recently and occupies part of the premises of D. T. Miller and Sons, 18/22, Narrow Street, London, E.14. A wide range of spare parts is stored and the service section can carry out repairs to fuel pumps, valves, &c., while an electric hoist and gantry is provided to serve ships lying alongside the quay.

ALUMINIUM-SHEATHED CABLES.—We are informed by Johnson and Phillips, Ltd., that, following extensive investigations and tests, the company's aluminium-sheathed rubber-insulated cables were found to provide 100 per cent electrical screening with minimum weight and, as a result, the Royal Netherlands Admiralty has adopted this form of cable for installation on two cruisers and some destroyers.

LAUNCHES OF NAVAL SHIPS.—The anti-submarine frigate H.M.S. "Torquay" was launched on July 1st from the Belfast yard of Harland and Wolff, Ltd., and a sister ship, H.M.S. "Whitby," was launched by Cammell Laird and Co., Ltd., on July 2nd. On July 1st, J. S. Doig (Grimsby), Ltd., put into the water the coastal minesweeper H.M.S. "Swanton," and the inshore minesweeper, H.M.S. "Mileham" was launched on the same day by M. W. Blackmore, of Bideford.

WATER TRACTOR TEST.—The Voith water tractor "Biene" recently demonstrated its capabilities of handling a large train of barges when it worked a total of forty-two barges which were lying in tiers of three alongside a quay in the Royal Victoria Dock. The barges represented a deadweight of about 6000 tons and a total displacement of 8500 tons, and the tractor, by means of the athwartships thrust from her Voith-Schneider propeller, moved the forward end of the train away from the quay and towed the complete train to the lock entrance. The barges were then handled in groups of twelve through the lock into the river at a quicker rate, it is claimed, than by the normal methods associated with a screw tug.

COASTAL SHIPPING ADVISORY COMMITTEE.—The Minister of Transport and Civil Aviation, Mr. Alan Lennox-Boyd, has been informed by the British Transport Commission that it has nominated Mr. David Blee (chief of commercial services), Mr. C. K. Bird (chief regional manager, Eastern Region), and Mr. J. R. Pike (chief rates and charges officer, Department of Chief of Commercial Services), to the Coastal Shipping Advisory Committee, set up under Section 71 of the Transport Act, 1947. These gentlemen will replace Mr. T. F. Cameron (chief regional manager, Scottish Region), Mr. C. P. Hopkins (chief regional manager, Southern Region), and Mr. D. Murray (chief freight officer, Department of Chief of Commercial Services) on the committee.

Miscellanea

RESEARCH STATION.—The Anglo-Iranian Oil Company, Ltd., has produced a booklet entitled *Research at Sunbury*, which describes and illustrates the work of the company's various research sections.

SWISS HIGH-POWER TESTING PLANT.—We regret that in our article describing the Oerlikon Engineering Company's high-power testing plant (July 2, 1954), Fig. 8 on page 24 was inadvertently reproduced upside down.

LIGHT ALLOY AIR RESERVOIRS.—We are informed that the Metropolitan-Vickers Electrical Company, Ltd., the Westinghouse Brake and Signal Company, Ltd., and James Booth and Co., Ltd., have developed a light alloy air reservoir. One of the reservoirs is to undergo service trials on a gas turbine locomotive and another will be tested on a diesel-electric shunting locomotive.

ALUMINIUM PASTE.—We have received from the English Metal Powder Company, Ltd., West Drayton, Middlesex, a copy of a booklet, entitled "Aluminium Paste," which discusses the manufacture of aluminium paste, its properties and characteristics which are set out in tabular form. A section of the booklet deals with the composition of aluminium paint and lacquer, such as oil varnishes, bituminous varnishes, cellulose lacquers and special lacquers.

TRANSPORT CONTAINERS.—The Ministry of Transport and Civil Aviation states that from January 1, 1955, covered containers may be accepted for transport to and about the Continent under Customs seal provided they comply with requirements approved by the Inland Transport Committee of the Economic Commission for Europe and are marked with an approved sign.

THE TELEPHONE SYSTEM IN GREAT BRITAIN.—It is announced that the number of telephone exchange lines in the United Kingdom at the end of March last was 3,750,000, and taking extension lines into account there were more than 6,000,000 telephones in service. Shortages of equipment still make it impossible to meet the demands for telephones in all areas. The introduction of shared service introduced in 1948 helped to provide more telephones, and there are now more than 742,000 subscribers sharing lines.

CENTENARY OF THE BIRTH OF SIR CHARLES A. PARSONS.—The centenary of the birth of Sir Charles A. Parsons is being commemorated at the Science Museum, South Kensington, for about three months by a special display of his original 7½kW, high-speed steam turbo-generator of 1884, which is exhibited by the side of a scale model, one-sixteenth full size, of a modern Parsons 50,000kW steam turbo-alternator. As both exhibits occupy the same space, the vast development in power production over half a century is strikingly shown. Photographs show other important developments in mechanical, electrical and marine engineering and in the optical industry, due to his pioneer researches and inventions.

PILLAR DRILLING MACHINES.—We are informed by B. Elliott and Co., Ltd., Victoria Works, London, N.W.10, that it has now introduced an improved design of its "Progress" No. 3 pillar drilling machine. The capacity of this machine has been increased to 1¼in in steel and the head is now bolted on to the flanged column, which has an increased diameter of 4½in. The forward and reverse switch of the machine has been placed in a more convenient position and a table with a larger working surface is fitted. As before, the machine can be supplied with a 1400 r.p.m. motor, giving a range of five spindle speeds from 110 to 1780 r.p.m., or a 960 r.p.m. motor giving spindle speeds from 70 to 1180 r.p.m.

SPRING-LOADED CHOCK FOR MINES.—Particulars have been received from the National Coal Board of a spring-loaded chock, designed to set itself automatically against the roof it is to support, which has been developed by Mr. David Wardlaw. Based on the telescopic principle, the main body of the chock consists of two steel tubes, one sliding within another. The lower tube is split down its length and is encircled by a clamp, so that when the inner tube is adjusted to the necessary height the clamp, which has a toggle action, tightens the outer tube to hold the inner tube in place. A strong coil spring within the two tubes is arranged to hold the head of the chock against the roof when the clamp is slack, and the chock is compressed before it is taken to the face. When it is in position, the clamp is released and the spring comes into effect to hold the chock against the roof while the clamp is tightened. A plate across the top of the chock carries two or more chock releases of the usual sliding form for quick release purposes. We are informed that a chock of this design was used in a 4ft 6in seam at Whitrigg Colliery, Scotland, for five months and gave satisfactory service.

Launches and Trial Trips

ATLANTIC LADY, oil tanker; built by the Ateliers et Chantiers de la Seine Maritime for Atlantic Oil Carriers; length between perpendiculars 538ft 1in, breadth moulded 73ft 8¼in, depth 40ft 6in, draught 30ft 6in, deadweight 19,800 tons; two 300kW turbo-generators, one 125kW diesel-driven generator; one set of double-reduction geared Rateau-Bretagne turbines, 8900 s.h.p., steam supplied at 569 lb per square inch and 896 deg. Fah. by two Babcock and Wilcox water-tube boilers. Trial, June.

CLAN ROBERTSON, cargo liner; built by the Greenock Dockyard Company, Ltd., for the Clan Line Steamers, Ltd.; length between perpendiculars 465ft, breadth moulded 65ft 6in, depth moulded to upper deck 39ft 7½in, deadweight 10,100 tons on 27ft 3in mean draught; service speed 17 knots; twelve passengers; three complete decks, five cargo holds, ten 5-ton, four 7-ton and two 15-ton, two 40-ton and one 80-ton derricks, electrical deck machinery; three 260kW diesel-driven generators; one set of Parsons double-reduction geared, reaction, triple-expansion turbines, 9400 s.h.p. at 106 r.p.m. of the propeller, 10,340 s.h.p. maximum power, steam supplied at 415 lb per square inch and 750 deg. Fah. by two Babcock and Wilcox water-tube boilers. Trial, June 24th and 25th.

CERINTHUS, oil tanker; built by Harland and Wolff, Ltd., at Belfast, for the Hadley Shipping Company, Ltd.; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, deadweight 18,000 tons; thirty-three cargo oil compartments; two 550kW turbine-driven alternators, one 200kW diesel-driven alternator, one set of double-reduction geared turbines, 7500 s.h.p., steam supplied at 500 lb per square inch and 800 deg. Fah. by two Babcock and Wilcox water-tube boilers. Launch, June 29th.

CICERO, cargo ship; built by Henry Robb, Ltd., for Ellerman's Wilson Line, Ltd.; length between perpendiculars 290ft, breadth moulded 48ft 6in, depth moulded to upper deck 27ft, deadweight 2400 tons on 17ft 9in mean draught, gross tonnage 2497, service speed 13 knots, two 60kW and one 30kW steam-driven generators; triple-expansion steam engine, cylinder diameters 20in, 34in and 56in by 39in stroke, Bauer-Wach exhaust turbine, 2460 i.h.p. at 105 r.p.m., steam supplied at 225 lb per square inch and 180 deg. Fah. by two Scotch boilers. Trial, June 29th.

CANOPIC, refrigerated cargo ship, built by Vickers-Armstrongs, Ltd., at Walker, for the Shaw Savill and Albion Company, Ltd.; length between perpendiculars 481ft, breadth moulded 69ft, depth moulded to upper deck 33ft 4½in, load draught 30ft 3in, deadweight 11,500 tons, insulated cargo 300,000 cubic feet, general cargo 340,000 cubic feet, six main holds; two Harland and Wolff six-cylinder diesel engines, 14,300 s.h.p., trial speed 18½ knots. Launch, June 30th.

FREDERICK T. EVERARD, coaster; built by the Goole Shipbuilding and Repairing Company, Ltd., for F. T. Everard and Sons, Ltd.; length 285ft, breadth 42ft, depth 19ft 3in, deadweight 3300 tons; Newbury diesel engine, 1600 b.h.p. at 250 r.p.m. Launch, July 1st.

HELCION, oil tanker; built by Swan, Hunter and Wigham Richardson at the Wallsend Shipyard for Shell Tankers, Ltd.; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, load draught 29ft 7½in, deadweight 18,000 tons, service speed 14½ knots; one cargo pump room, four turbine-driven vertical, centrifugal, 400 tons per hour cargo oil pumps, two stripping pumps, steam deck machinery; one set of B.T.H. steam turbo-electric machinery, two alternators and one electric propelling motor, 8300 s.h.p. at 103 r.p.m. maximum output, 7500 s.h.p. at 100 r.p.m. normal output, steam supplied at 450 lb per square inch and 750 deg. Fah. by two Babcock and Wilcox water-tube boilers, built by the Wallsend Slipway and Engineering Company, Ltd.; two 550kW turbine-driven alternators, one 200kW diesel-driven alternator. Launch, July 2nd.

LOUGA, cargo liner; built by the Ateliers et Chantiers de la Loire, Nantes, for the Compagnie Maritime de Chargeurs Réunis; length between perpendiculars 399ft 8in, breadth moulded 55ft 9in, depth to shelter deck 35ft 1½in, draught loaded 24ft 1in, displacement 10,940 tons, deadweight 7220 tons, service speed 15·3 knots; two 240kW diesel-driven generators; Sulzer two-stroke, single-acting diesel engine, eight cylinders, 720mm diameter by 1250mm stroke, 5000 h.p. at 120 r.p.m., 6000 h.p. at 130 r.p.m. Trial, July.

Personal and Business

MR. HUGH MEREWETHER has joined Hawker Aircraft, Ltd., as a test pilot of "Hunter" fighters.

CAPTAIN G. H. PETERS, R.N., has been appointed director of the trade division in the Admiralty.

MR. G. D. L. GOSLETT, Mr. C. B. Innes and Mr. B. L. Irwin Jun., have been appointed directors of Ruberoid Company, Ltd.

PERMALI, Ltd., Bristol Road, Gloucester, states that its London address is now Windsor House, 46, Victoria Street, S.W.1 (telephone, Abbey 6494).

MR. A. J. LOCKE has been appointed manager of the Hong Kong service depot of The Marconi International Marine Communication Company, Ltd.

MR. BRYAN DONKIN, M.I.E.E., has accepted an invitation to succeed Mr. C. T. Melling, M.I.E.E., as president of the Association of Supervising Electrical Engineers.

Mr. J. MURRAY GAMMER, stores buyer for the North Thames Gas Board, has been elected chairman of the London branch of the Purchasing Officers Association.

ANGLO-SWISS SCREW COMPANY, Ltd., Trout Road, West Drayton, Middlesex, has opened a sales office at 12, St. Ann's Square, Manchester, 2, in charge of Mr. T. Rogers.

MR. R. W. FOXLEE, M.I.C.E., formerly engineer-in-chief to the Crown Agents for the Colonies, has joined Coode and Partners, 9, Victoria Street, London, S.W.1, as a consultant.

MR. R. WILLIS and Mr. P. E. H. Wilde have been appointed directors of Sheffield Forge and Rolling Mills Company, Ltd., Millsands, Sheffield, which has recently been acquired by Darwins, Ltd.

MR. W. BAYLEY, M.I.Mech.E., has retired from his position as head of the consultative and new construction department of the British Engine Boiler Insurance Company, Ltd., after thirty-one years' service.

SIR ARTHUR WHITAKER, K.C.B., formerly Civil Engineer-in-Chief of the Admiralty, has joined, as a partner, the firm of Messrs. Livesey and Henderson, National House, 12–18, Moorgate, London, E.C.2.

RUSTON AND HORNSBY, Ltd., Lincoln, states that Mr. J. D. Thorn, A.M.I.Mech.E., has been appointed chief engineer, engine department, in succession to Mr. I. Wans, M.I.Mech.E., who is resigning from the company.

MR. J. F. LOCKWOOD, chairman and managing director of Henry Simon, Ltd., has been appointed to the boards of Electric and Musical Industries, Ltd., the Gramophone Company, Ltd., and the Columbia Gramophone Company, Ltd.

THE H. K. FERGUSON COMPANY, of Cleveland, Ohio, announces the formation of a wholly-owned British subsidiary. The new company is designated H. K. Ferguson Company of Great Britain, Ltd.; its offices are at 19, Berkeley Street, London, W.1.

MR. OMER G. VOSS has been appointed managing director of International Harvester Company of Great Britain, Ltd., 259, City Road, London, E.C.1, in succession to Mr. Brooks McCormick, who has returned to Chicago to take up executive duties with the company.

THE P. AND O. STEAM NAVIGATION COMPANY announces the reorganisation of the superintendent engineer's department. Mr. S. A. Smith has become engineering adviser, and Mr. W. Girvan has succeeded him as superintendent engineer. Mr. J. B. Annal, Mr. H. A. Roper and Mr. P. Job have been appointed assistant superintendent engineers.

British Patent Specifications

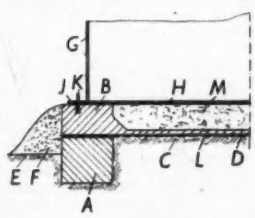
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

GAS-HOLDERS

710,186. April 19, 1951.—FOUNDATIONS FOR GAS-HOLDERS, Maschinenfabrik Augsburg-Nürnberg A.G., of Nürnberg, Germany.

The invention relates to foundations for gas-holders and like constructions and its object is to construct foundations in such a way that deforming effects of horizontal soil movements are kept, as far as possible, away from the supported construction. The drawing shows an example of construction. *A* is the lower part of the foundation which supports an upper part *B* and which in this case may consist of a large number of separate foundation members which do not extend below the entire area of the upper part, the remaining area of which is supported by the soil. The upper part consists of a disc of concrete which is rigid in the horizontal direction and flexible in the vertical one. Between the upper part



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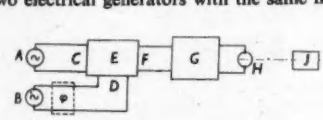
of the foundation and the separate foundation members *A* of the lower part and the soil *C* there is a sliding layer *D* of sand which allows a horizontal displacement of the lower foundation members *A* relatively to the upper part *B*. *E* shows the level of the soil, from which it can be seen that the part *B* lies above the soil so that it is not subjected directly to pressures or tears by the surrounding earth region. However, in order to protect the sliding layer *D* against freezing a loose bank of soil *F* is placed around the foundation. The gas-holder, which consists in the usual way of a cylindrical or polygonal wall *G* and a bottom *H*, is provided with flanges *J* having holes through which project vertical bolts *K*. These can move in the holes of the flanges freely in the vertical direction and are firmly anchored in the upper part *B* of the foundation. For economical reasons and for ensuring flexibility in the vertical direction, the upper part *B* of the foundation consists in its middle only of a thin plate *L* and receives a filling *M* of earth for supporting the bottom *H* of the gas-holder.—*June* 9, 1954.

MARINE ENGINEERING

710,675. February 8, 1952.—PROPELLER SYSTEM FOR TWIN SCREW VESSELS, Forsvarets Forskningsinstitutt, Storgaten 33, Oslo, Norway. (*Inventor: Fredrik Moller.*)

The object of the invention is to provide a propeller system with means for the adjustment of the screws in such relative position that there is a minimum vibration. In the drawing, *A* and *B* are two electrical generators with the same number



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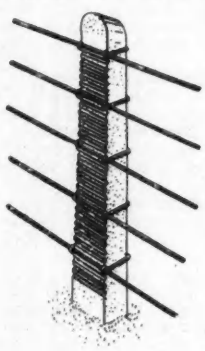
of poles each connected to a screw shaft. The voltages produced by the two generators consequently are of a frequency proportional to the number of revolutions of the appropriate screw shaft. Each of the voltages, *C* and *D*, of the generators *A* and *B* is applied to a separate set of input terminals of a phase sensitive detector *E* of suitable construction. A voltage *F* will then appear across the output terminals of *E*, the frequency of the voltages being equal to the difference between the frequencies of the two a.c. voltages *C* and *D*. If the frequencies are equal, the output voltage from *E* is a d.c. voltage, the polarity and strength of which depends upon the phase difference between the input voltage *C* and *D*. The output voltage *F* is applied to a servomotor device *G* which is provided with a motor *H* coupled to the velocity regulator *J* of the propulsion machine associated with the screw, the shaft of which is driving the generator *B*. When the voltages *C* and *D* are 90 deg. phase displaced the voltage *F* is zero and the motor *H* is inactive. If a phase displacement arises between the two voltages, the motor is driven in one direction or the other, whereby the number of revolutions of the associated propulsion machine is readjusted until the initial phase relationship is restored. Now, if a variation in the phase relationship is caused by manual action or in any other way the voltages *C* and *D* are still in synchronism, but the phase sensitive detector produces a voltage *F* which will cause the motor *H* to re-start and thereby actuate the regulator *J* until the state of quiescence is re-established, this time with another relative position of the blades of the two screws. Through tests with different adjustments of the phase relationship it is possible to ascertain the adjustment which gives the minimum vibrations and the arrangement will then ensure that this condition is maintained.—*June* 16, 1954.

FENCING

710,430. September 17, 1951.—FENCING POST, Ivan Arthur Duke, 7, Ngaroma Road, Epsom, Auckland, S.E.3, New Zealand.

Referring to the drawing, a rectangular, four-sided fencing post has corrugations or recesses transversely across the surface of one wall. The wire strands forming the fence are retained in the recesses by



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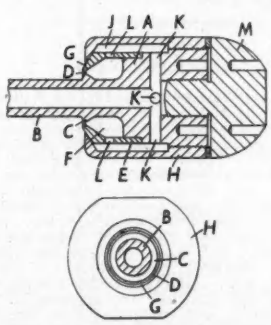
wire clips formed with hooked ends. The strands of wire can be adjusted in desired vertical relationship on the post without disconnection of the clips. The series of corrugations or recesses may extend over substantially the whole of one surface of the wall of the post as shown or may be provided in spaced series. Alternative post constructions are also shown in the specification.—*June* 9, 1954.

BURNERS AND SPRAYERS

710,586. March 13, 1952.—LIQUID FUEL BURNER NOZZLES, Joseph Lucas (Industries), Ltd., Great King Street, Birmingham, 19. (*Inventors: Eric Samuel Collinson and Peter Eugene Sherburn.*)

The invention relates to liquid fuel burner nozzles of the swirl type for use in the combustion chamber of a jet-engine gas turbine. Referring to the drawing, a cylindrical part *A* has formed in it an axial fuel inlet passage, and on the front end of this part is a fuel pipe *B*. Also there is formed on it an annular lip *C* which serves as the inner edge of an



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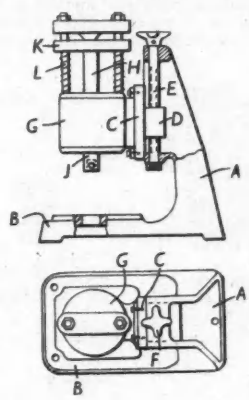
annular discharge orifice *D*. A separate annular part *E* is mounted on *A* and forms with that part a swirl chamber *F*, which tapers towards the discharge orifice, the outer edge of the orifice being formed by a lip *G*. The two parts *A* and *E* are held together by an outer sleeve *H*, the sleeve being shaped to provide with the two parts an annular fuel passage *J*, which at one end communicates with radial ports *K* in *A*, and which at the other end communicates with the swirl chamber through tangential passages *L*. In the example shown, there is screwed on the rear end of the part *A* a cover piece *M*, which on detachment gives access to the bore for cleaning purposes. The arrangement is such that fuel flowing along the pipe *B* to the nozzle, passes through the radial ports *K* to the passage *J* and thence to the swirl chamber *F*. The fuel is discharged from this chamber through the annular orifice *D* in the form of a hollow cone surrounding the pipe *B*. By the invention, it is claimed that the desired arrangement of the fuel pipe can be effected in a very simple and convenient manner—*June* 16, 1954.

ELECTRICAL ENGINEERING

710,464. April 8, 1952.—ELECTROMAGNETIC HAMMER, Elmeg Elektro-Mechanik G.m.b.H., Peine, Hanover, Germany.

The object of the present invention is to provide an electromagnetic hammer which comprises very few, easily obtainable parts, and which is simple to operate. Referring to the drawing, there is shown a stationary support member *A* having a base *B* upon which a work piece is mounted. Mounted on the support *A* is a plate member *C* having an extension *D* which is formed with a threaded bore normal to the base portion. A threaded member *E* is rotatably mounted on the support *A* and engages the extension so that upon turning *E* the plate member



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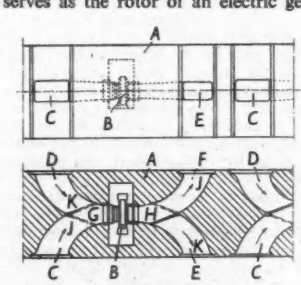
C may be moved toward or away from the base portion. Mounted on the plate member *C* is a coil *G* through which an armature *H* extends, this armature having a lower end portion *J* to which a tool is connected. The upper end of armature *H* is connected to a bar *K* for movement and several pins *L* mounted on the coil and extending upwards, pass through openings formed in the bar *K* and are connected at their upper ends to a cross head. Mounted on each pin *L* is a coil spring which urges the bar *K* toward the cross head and maintains the bar in engagement with it when the coil is unenergised. When the coil is energised it moves the armature *H* forcibly toward the base to produce the hammering action. Modified designs are also shown in the specification.—*June* 16, 1954.

CIVIL ENGINEERING

710,685. May 5, 1952.—TIDAL POWER INSTALLATIONS, Escher Wyss Maschinenfabrik G.m.b.H., Ravensburg, Wurttemburg, Germany.

In the upper drawing a dam *A* between the sea and a reservoir is shown. A number of axial-flow turbines, each having a horizontal axis of rotation, are arranged in the dam. The turbines are "tubular turbines," the blades being surrounded by a ring which serves as the rotor of an electric generator.



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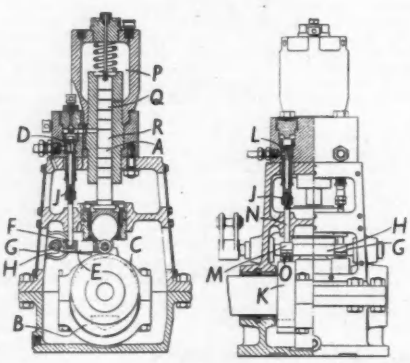
Only one turbine *B* is shown. Two intakes *C* and *D* and two discharges *E* and *F*, are arranged symmetrically to the axis of rotation of each turbine, the mean axes of the intakes and discharges all being horizontal and in one plane. Each turbine has an adjustable hinged flap *G* on its intake side and a further adjustable hinged flap *H* on its discharge side. When the flaps are in the positions shown in

full lines in the lower view, the intakes *C*, the turbines and the discharges *F* are traversed in the direction indicated by the full-line arrows *J*, the flow through the intakes *D* and the discharges *E* being blocked. When the positions of the flaps *G* and *H* are as shown in the chain-dotted lines, the intakes *D*, the turbines and the discharges *E* are traversed in the direction of the arrows *K* shown in chain-dotted lines, the flow through the intakes *C* and the discharges *F* being blocked by the flaps *G* and *H*. Both when the water flow is in the direction of the arrows *J* and when it is in the direction of the arrows *K*, the flow from the intake to the discharge of each turbine follows a substantially "S"-shaped path, and in addition the axial flow through each turbine is always in the same direction and each turbine always rotates in the same direction. A modified arrangement is also shown in the specification.—*June* 16. 1954.

INTERNAL COMBUSTION ENGINES

710,496. February 26, 1951.—FUEL INJECTION SYSTEMS, William Doxford and Sons, Ltd., William Hamilton Purdie, Percy Jackson and John George Gunn, all of Pallion Yard, Sunderland.

The invention provides improved means for controlling the timing of the fuel injected, and its amount, with simplified reversing means. As the



No. 710,496

drawings show, the pump plunger *A* is driven by an eccentric *B*, mounted on the shaft, alongside of which is a further eccentric *C*, operating a spring-loaded valve *D* through a lever *E*, and tappet *F*. This valve serves as the inlet valve for the pump, and also controls the amount of fuel pumped. The lever *E* is fulcrummed on an eccentric *G* on shaft *H*, and the tappet rod *F* has adjusting nuts *J*. On the other side of the eccentric *B* is a cam *K*, which operates a spring-loaded discharge valve *L* through a lever *M* and a tappet *N*. The lever *M* is also mounted on an eccentric *O* on the shaft *H*, and the tappet also has adjusting nuts *J*. The pump has an accumulator chamber *P* and an accumulator plunger *Q*. The accumulator chamber is charged with oil at a high pressure by means external to the pump, as described and claimed in Specification No. 710,495 co-pending, so that the chamber is kept full of oil. In operation, as the eccentric *B* is turned by the engine, the pump plunger *A* makes its upward stroke during the compression stroke of the engine, and fuel is initially returned from the pump cylinder through the inlet and quantity control valve *D* to the fuel supply. The valve is permitted to close by rotation of eccentric *C*, the motion of the lever *E* and the tappet *F*. The fuel to be injected into the cylinder is trapped in the space *R* between the two plungers, and the continued upward movement of the plunger *A* lifts the accumulator plunger *Q* against the pressure in the chamber *P*. At the correct time in the compression stroke of the engine cycle, the cam *K* lifts the discharge valve *L* and the injection of the fuel in the space *R* then takes place by the downward movement of the accumulator plunger *Q* under the action of the pressure in the chamber *P*. The continued movement of the plunger *B* causes the downstroke of the plunger *A*, and fuel is drawn into the pump chamber. Soon after the beginning of this downstroke of the plunger, the valve *L* is permitted to close by the cam *K*. The rotation of the shaft adjusts the fulcrum of the lever *E*, and has the effect of varying the duration of the opening of the valve *D*, during the upward stroke of the plunger *A*, and thus of varying the quantity of fuel trapped in the space *R* and subsequently injected into the engine cylinder. The same rotation of the shaft *H* also varies the time of opening of the valve *L* and thereby adjusts the timing of the beginning of injection, an important factor in the slow running of a marine engine. Modified arrangements are also described in the specification.—*June* 16, 1954.

Technical Reports

The Protection of Hydraulic Couplings Against Overheating. By P. G. Taigel, B.Sc., Ph.D., A.M.I.Mech.E. Research Report No. 85. Safety in Mines Research Establishment, Portobello Street, Sheffield. Price 1s. 6d.—The experiments described in this report form part of an investigation following an underground fire in a scraper-chain conveyor drive. It describes the performance of the hydraulic coupling under various conditions of operation.

Hydraulic couplings of the traction type are being used to an increasing extent in conveyor drives to provide improved starting conditions. In them slip at full load is small and heating negligible, but slip increases rapidly with overload and heating occurs. Couplings are safeguarded against such heating by fitting a safety plug filled with an alloy which is intended to fuse at 185 deg. Fah. and allow the oil in the coupling to escape.

A fire on a conveyor drive fitted with a fluid coupling led to an investigation of the behaviour of the coupling and fusible safety plug under various conditions of load. A manufacturing defect in the plug was discovered which permitted considerable overheating, but the experiments have so far failed to produce ignition of oil from a hot coupling. Measurement of the tripping times for the motor overload cut-outs, which should normally protect the motor and coupling, showed that for all settings the time to trip was short enough to prevent heating up of the coupling.

Plugs from couplings in use at various collieries were tested for melting temperature and wide discrepancies found. Metallurgical investigations have shown an interesting phenomenon, the selective migration of an alloying element at a liquid-solid interface. This, it is thought, may have a bearing on the variation in the melting points of the fusible plugs. The factors to be considered in the operation and protection of hydraulic couplings are discussed in the report and a warning is given of the danger of their misuse.

Cathodic Protection of Pipelines and Storage Tanks. By V. A. Pritula. H.M. Stationery Office. Price 10s.—Corrosion of underground water pipelines is estimated to cost this country at least £5,000,000 each year. One of the ideas for combating this corrosion which has been investigated and applied in various countries is cathodic protection. This book has been translated from the Russian and was originally published in 1950 by the Russian Ministry of the Petroleum Industry. It is liberally illustrated with diagrams and deals with the theory of the subject and provides practical details on the method of carrying out this kind of protection.

Book of Reference

Clarke's Tables and Memoranda. Tenth edition. Revised and enlarged by P. Honey, A.M.I.E.E., and W. J. Woolgar, F.R.San.I. London: B. T. Batsford, Ltd., 4, Fitzhardinge Street, W.1. Price 8s. 6d.—This handy book of reference for plumbers, builders, sanitary, heating and electrical engineers has been completely reset and enlarged. A number of new British standards have been introduced, together with a new section on gas supply. As in previous editions, the book provides a large amount of varied information of practical use to tradesmen in their day-to-day work.

Contracts

CONTRACTS have been placed by the British Electricity Authority during the past month for power stations, transforming stations and transmission lines amounting in the aggregate to £26,735,766. The principal contracts include Acton Lane "B" power station, Willesden, two 30MW turbo-generators, condensing and feed heating plant (Richardsons, Westgarth (Liverpool), Ltd.); Belvedere power station, Kent, two 60MW turbo-generators (English Electric Company, Ltd.), three 550,000 lb per hour boilers (John Brown and Co. (Clydebank), Ltd.), and condensing and feed heating plants for two 60MW turbo-generators (Mirrlees Watson Company, Ltd.); Hackney power station, one 30MW turbo-generator and feed heating plant (C. A. Parsons and Co., Ltd.), and condensing plant for one 30MW turbo-generator (Worthington-Simpson, Ltd.); Barking power station, London, one 550,000 lb per hour boiler (Babcock and Wilcox, Ltd.); Brighton "B" power station, superstructure work (John Morgan (London), Ltd.), and one 60MW turbo-generator, condensing and feed heating plant) Richardsons, Westgarth (Liverpool), Ltd.); East Yelland power station, near Barnstaple, one 30MW turbo-generator and feed heating plant (C. A. Parsons and Co., Ltd.), condensing plant for one 30MW turbo-generator (G. and J. Weir, Ltd.), and one 180,000 lb per hour boiler (John Thompson Water Tube Boilers, Ltd.); Goldington power station, Bedford, one 30MW turbo-generator (British Thomson-Houston Company, Ltd.), and condensing and feed heating plant for one 30MW turbo-generator (G. and J. Weir, Ltd.); South Denes power station, Yarmouth, ash and dust handling (B.V.C. Industrial Constructions, Ltd.); Tilbury power station, one 540,000 lb per hour boiler (John Thompson Water Tube Boilers, Ltd.); Castle Donington power station, near Derby, two 100MW turbo-generators, condensing and feed heating plants (Metropolitan-Vickers Electrical Company, Ltd.), and three cooling towers (Mitchell Construction Company); Willington power station, near Derby, one 100MW turbo-generator, condensing and feed heating plant (English Electric Company, Ltd.), and ash and dust handling plant (Babcock and Wilcox, Ltd.); Hams Hall "C" power station, near Birmingham, three 550,000 lb per hour boilers (Simon-Carves, Ltd.), and coal handling plant (Mitchell Engineering, Ltd.); Ocker Hill power station, Tipton, Staffs, two 30MW turbo-generators with feed water heating, condensing plant and auxiliary apparatus (Richardsons, Westgarth and Co., Ltd.); Uskmouth "B" power station, Newport, one 60MW turbo-generator (English Electric Company, Ltd.), and condensing and feed heating plant for one 60MW turbo-generator (Vickers-Armstrongs, Ltd.); Dolgarrog power station, Caernarvonshire, one 10MW hydro-turbo-generator (Boving and Co., Ltd.); Ferrybridge "B" power station, Yorks, one 100MW turbo-generator, condensing and feed heating plant (C. A. Parsons and Co., Ltd.); Wakefield power station, Yorks, one 60MW turbo-generator and feed heating plant (English Electric Company, Ltd.); Skelton Grange power station, Leeds, three 550,000 lb per hour boilers (International Combustion, Ltd.); Thornhill power station, near Dewsbury, 33kV main switchgear (A. Reyrolle and Co., Ltd.); Elland power station, Yorks, one 60MW turbo-generator (Metropolitan-Vickers Electrical Company, Ltd.), condensing and feed heating plant for one 60MW turbo-generator (Vickers-Armstrongs, Ltd.), and one 550,000 lb per hour boiler and ancillary equipment (Yarrow and Co., Ltd.); Mexborough power station, Yorks, two 30MW turbo-generators (English Electric Company, Ltd.); Stella North power station, near Newcastle upon Tyne, one 550,000 lb per hour boiler (Clarke, Chapman and Co., Ltd.); Stella South power station, one 550,000 lb per hour boiler (Clarke, Chapman and Co., Ltd.); Barony power station, Ayr, ash and dust handling plant (Babcock and Wilcox, Ltd.); Dalmarnock power station, Glasgow, one 60MW turbo-generator, condensing and feed heating plant (C. A. Parsons and Co., Ltd.), and coal handling plant (W. J. Jenkins and Co., Ltd.); Churchill-Melksham, Wilts, 132kV line (W.T. Henley's Telegraph Works Company, Ltd.).

THE UNITED STEEL COMPANIES, Ltd., acting on behalf of the British makers of permanent way materials, has signed a contract with the Seven-Year Plan Organisation in Persia for permanent way materials to the value of £5,000,000. The contract calls for the delivery over three years of 100,000 tons of rails and 4000 tons of fishplates, together with fishbolts, washers and turnouts.

THE GENERAL ELECTRIC COMPANY, Ltd., announces that a contract has been received by its Fraser and Chalmers Engineering Works, Erith, Kent, for a Chance coal preparation plant to the value of about £300,000, for the National Coal Board. The plant will be installed at Desford Colliery in No. 7 Area of the East Midlands division.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received an order for the supply of lanterns, control gear and lamps for a 3-mile extension to the Barry street lighting scheme, the first stage of which was completed last summer. The installation, which is hoped to be completed by August, will consist of 143 Mazda sodium enclosed lanterns, together with twenty-four cut-off units and all the necessary control gear and lamps.

THE ENGLISH ELECTRIC COMPANY, Ltd., states that negotiations have been completed with Whitehall Securities Corporation, Ltd., agents in London for Athens Piræus Electricity Company, Ltd., for the supply and construction of extensions to the St. George's Bay power station near Athens. The contract value is approximately £6,628,000. The equipment includes a 60MW hydrogen-cooled turbo-alternator and a 12·5MW topping turbo-alternator, exhausting into the existing turbines; three boilers operating at 930 lb per square inch, 915 deg. Fah.; switchgear for the control of the alternators and auxiliaries; building extensions and foundations, and a considerable quantity of substation equipment, including switchgear. The boiler installation will be able to burn pulverised lignite or oil.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASLIB

Fri. to Mon., Sept. 24th to 27th.—Church House, Westminster, London, S.W.1, 29th Annual Conference.

INSTITUTION OF PRODUCTION ENGINEERS

Wed. to Wed., July 7th to 14th.—Production Exhibition and Conference, National Hall, Olympia. The exhibition is open daily from 10 a.m. to 6 p.m. Conference programme: Wed., July 7th—Official opening, 11 a.m. Session I, 1954 Sir Alfred Herbert Paper, 3.30 p.m. Thurs., July 8th—Session II, "Productivity and National Resources," 11 a.m.; Session III, "Practical Applications of Production Engineering Research," "Production Engineering Research and the Information Services at Work in the Factory," 3 p.m. Fri., July 9th—Session IV—"Simplification by Selection," 11 a.m.; Session V—"Scientific Research and the Changing Pattern of British Industry," 3 p.m. Mon., July 12th—Session VI, "The Trade Union Attitude to Research and Productive Efficiency," 11 a.m.; Session VII, "Standardisation in the Process Industries," 3 p.m. Tues., July 13th—Session VIII, "Introduction of Work Study into Smaller Firms," 11 a.m.; Session IX, "Standards and Export," 3 p.m. Wed., July 14th—Session X, "Human Factors in Technological Change," 11 a.m.; Session XI, "It All Depends on Management," 3 p.m.